Power and The Engineer

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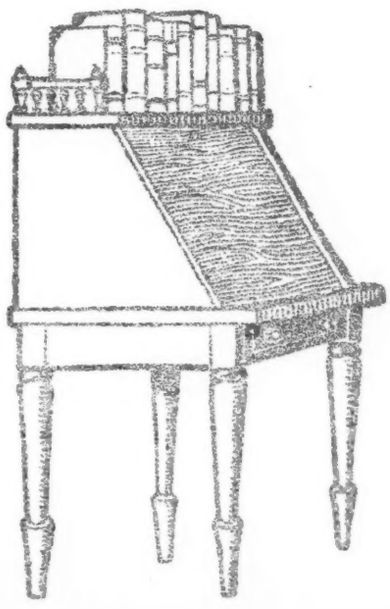
ALMOST every boy is sent to school to learn the three Rs. This much education is practically compulsory. He can't help but know *readin'*, *'ritin'* and *'rithmetic*. If his folks have the means, he goes up higher, —maybe. If he is of the right sort, he goes higher up anyhow. Possibly he goes to college. At any rate, he continues to soak up and store knowledge.

Knowledge is something a pickpocket can't take away from you. If you once get it, you own it forever. All knowledge is valuable,—in some way or another. Some knowledge is of direct or measurable value, while other kinds are of indirect worth.

For instance,—knowledge of how to fire a boiler is worth at least 20 cents for every hour it is used. Such knowledge is of direct value.

Knowledge of how to analyze flue gas may be catalogued as of indirect value. It makes a perfectly good running engineer or fireman worth more.



Some day it will be discovered that the boilers are not doing their work as cheaply as they should. Poor combustion may be to blame. The man who can use the gas analyzer and who knows what a gas analysis shows, is the fellow who stands the best chance of discovering the cause of the trouble. Then the time and the money which that chap invested in securing information on the subject will bring in a big dividend.

One of the hardest things in the world for the average man to do is to read a book dealing with abstract things. Yet there is much valuable knowledge stored in prosy old volumes.

With engineering books, just as with other kinds, some are classics and others are not worth the paper they are printed upon. Don't waste your time on any but the classics. It is much cheaper in the long run.

Every engineer should own a few books. He should see to it that all of those which he does own are the best that have been published on the subjects of which they treat. In addition to having the books, he should know what they contain.

The mere possession does not benefit anyone. The books should be read carefully at least once.

There is a difference between *skimming* a book and reading it carefully.

In one case the job is done in a short time and if the "skimmer" is lucky, he gets perhaps one-half of the meat which the book contains.

In the other case, the reader goes after it all; and gets it. He lets the full significance of each sentence sink in before he passes to the next one. His time is well spent. He will never have to do it over.

Let your engineering books be of the best, and don't be a "skimmer."

Continuous Records from Indicator

By N. L. Daney

The indicator has become an important factor in the operation of any plant. Not only does it aid the engineer to properly set his valves and to locate trouble, but it also proves invaluable in determining the power developed. The advancement of the steam engine to its present state of high perfection has necessitated a corresponding development in the methods of indicating. As a result, we now have electrically controlled systems of indication which give simultaneous diagrams from both ends of all cylinders, and at the same time automatically record such information as is required for complete power calculations. One of these systems is described and illustrated.

The indicator has been an appendage to the steam engine since the days of Watt, and has enjoyed the same marked development as the engine. For years the indicator was little used except by experts, and was looked upon by the majority of operating engineers as a mysterious piece of mechanism. The modern engineer, however, is no longer mystified by the indicator and has long since given up the practice of setting valves by means of tram and chisel marks. The indicator is now his friend in the hour of need, and to it he looks for the solution of many of his troubles.

The earlier types of indicator gave diagrams which were crude in outline and showed nothing by which the valves could be properly adjusted or a determination made of their relation to the stroke of the piston; in fact, they would have been useless with the modern high-speed engine. Many details which gave little trouble at low speeds and low pressures would cause serious errors under the present practice of high speeds and pressures.

The various defects which were found in the older types of indicator have gradually been removed; some of them faults of mechanism, others of mechanical construction. To obtain trustworthy results in high-speed engines, an indicator must have extreme lightness, a fine adjustment of all the moving parts, and fine workmanship.

Methods of taking indicator diagrams have changed fully as much as the design of the instrument. Up to within a few years ago, one or possibly two indicators applied successively to the cylinders was all that was deemed necessary to give the engineer an idea of his valve setting and such information as was required on the power developed. But today the superintendents of the larger mills and power stations demand a number of diagrams taken from both ends of each cylinder simultaneously. One set of cards taken simultaneously will not suffice.

In rolling-mill and street-railway work, the steam pressures, vacuum and loads vary to such an extent that only diagrams taken simultaneously and continuously through a working cycle, will give the full information that is required for complete power calculations. This is accomplished only by means of the latest development in indicator construction, namely, the continuous-drum indicator, used in conjunction with such accessories as go to make up the equipment of the modern steam engineer.

The equipment herein described is considered by the writer to be especially efficient for power determinations under variable load conditions. It consists of one continuous indicator for each end of every cylinder and a chronograph so connected to the indicators that the speed at any point of the stroke can be found and identified with the proper card on the strip of continuous diagrams. The entire outfit after being set up and adjusted, can be operated and controlled by one man, who may or may not be located in close proximity to the engine. For instance, the engine under test may be driving a rolling mill and be located in a building separate from the mill proper. The engineer in charge of the test can, with this equipment, be located in the mill, where he is able to watch the number of pieces being rolled during the period of test, and still have complete control of the testing apparatus. Or, in indicating a generator engine with the switchboard located at some distant point, the engineer in charge of the test may station himself in front of the switchboard, where he can watch the load variations and catch his diagrams under any particular condition desired.

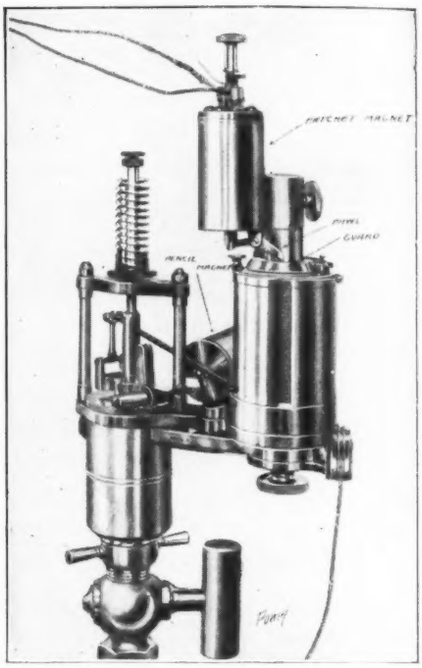


FIG. 2. INDICATOR COMPLETE WITH MAGNET

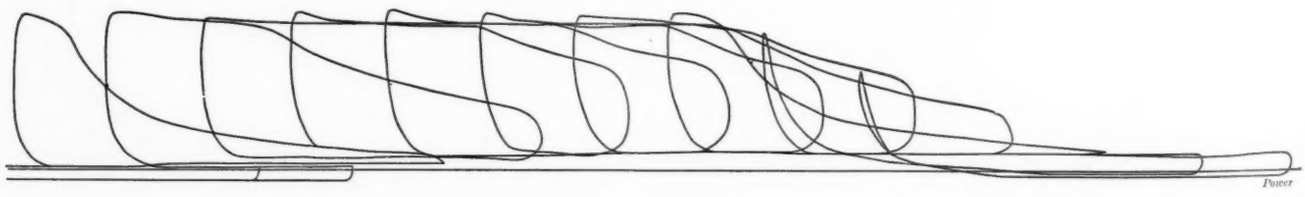


FIG. 1. SERIES OF DIAGRAMS SHOWING FLEXIBILITY OF SYSTEM

This flexibility of control is accomplished by electrically operated means; having the drums of the indicators and the pencil motions controlled by electromagnets. When no diagrams are being taken and the circuit is open, the pencil arms are not in contact with the paper, but when the circuit is closed by the operator, the pencil is pulled against the paper by the electromagnet. The same idea is carried out on the drum of the indicator. When the circuit is open, the

drum simply revolves as in a simple indicator, but when the circuit is closed, the electromagnet is energized and in turn engages a pawl on a ratchet on the face of the drum. This feeds the paper around the drum of the indicator.

The spacing of the diagrams is accomplished by regulating the number of teeth engaged by the ratchet pawl at each revolution of the drum. This control of the paper-feeding device is an original idea, and to the best of the writer's knowledge, is used only on this equipment. As arranged on the majority of continuous-drum indicators, the feed would have to be thrown in on each indicator separately by some one other than the operator. The main disadvantage of this latter system is that the feed may be thrown in some little time before the desired load condition is attained, and during this intervening period the paper continues to feed. With this electrically controlled feed, the operator may start his feed whenever the conditions are right and therefore not waste any paper. The flexibility of this system is illustrated by referring to the single strip of diagrams shown in Fig. 1.

The indicator used is a modification of the standard Crosby continuous-drum type and is designed to use a roll of paper 2 inches wide and 12 feet long, upon which is made a series of diagrams.

A view of the indicator with magnet attachment is shown in Fig. 2. The roll of paper is located within an opening in the shell of the drum, thence passes around the outside of the drum and inward to the central cylinder to which it is attached. The central cylinder is concentric with the drum, and after the paper has been wound upon it, may be withdrawn through the top. The piston is connected to the outside spring by means of a hollow rod through which a smaller rod actuates the pencil motion. The action of the outside spring differs from the ordinary inside type by placing the spring in tension when in operation, rather than in compression. The indicator is supplied with a Sargent electromagnet for operating the pencil, the connection to which is plainly shown in the illustration, although the surface ratchet which engages the pawl of the magnet is not visible, it being covered by the guard over which the pawl glides. In Fig. 3, which is a top view of the indicator, the ratchet is plainly shown.

With an indicator thus attached to both ends of each cylinder of the engine, an exact power determination can be obtained for any one stroke or any working cycle.

The speed of the engine is taken by a chronograph. When using an ordinary tachograph it is impossible under varying speeds to associate any one diagram with its corresponding speed. But with the chronograph operated electrically and in parallel with the indicators, each diagram has its own individual speed indication. The number of revolutions indicated by the markings of the chronograph corresponds exactly with the number of diagrams on the continuous strip.

The chronograph used by the writer is manufactured by William Gaertner &

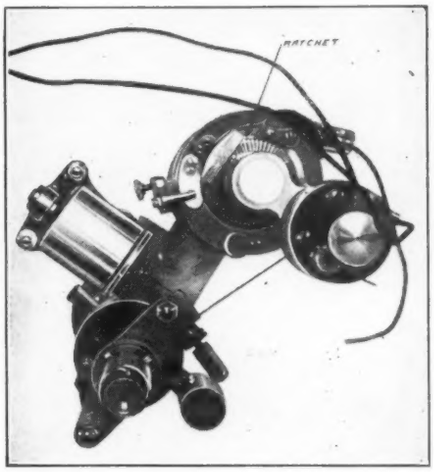


FIG. 3. TOP VIEW OF INDICATOR

Co., and its construction is shown in Fig. 4. The mechanism is mounted on a metal base *A*, and is driven by weights (not shown) supported by the wire cable *B*. The speed of the instrument is controlled by a flyball governor *C* which is driven direct from the cable drum; the speed at which the instrument is to be run being adjusted by moving the flyballs in or out on their supporting rods. Any increase in speed above that at which the instrument is set, causes the balls to fly out and force a small spring on the supporting rod against a fiber friction disk; this immediately reducing the speed to normal. The drum *D*, upon which the record sheet is wrapped, is driven by gears and makes one revolution in a given length of time. It is our practice to set this at 30 seconds. The circumference of the drum is such that a record 37.64 inches long is obtained per minute. This length permits of an accurate record being obtained. The record is made upon the revolving drum by either one of two pens *E*, mounted on a carriage driven by a lead screw with a ½-inch pitch. Upon the same carriage and connected to the arms supporting the pens are two electromagnets *F*; one magnet attached to and controlling each pen.

The power for operating these electromagnets is taken from the line that supplies the current for the magnets on the indicators; the only necessary accessory being a make-and-break switch so set that at some point of the engine stroke the switch will close and immediately open again, causing the electromagnets to operate and make a V-shaped notch in the line on the record sheet. The distance between any two successive jogs is measured and the speed of the drum being known the time represented by the distance is readily calculated. Fig. 5 shows a record taken from the chrono-

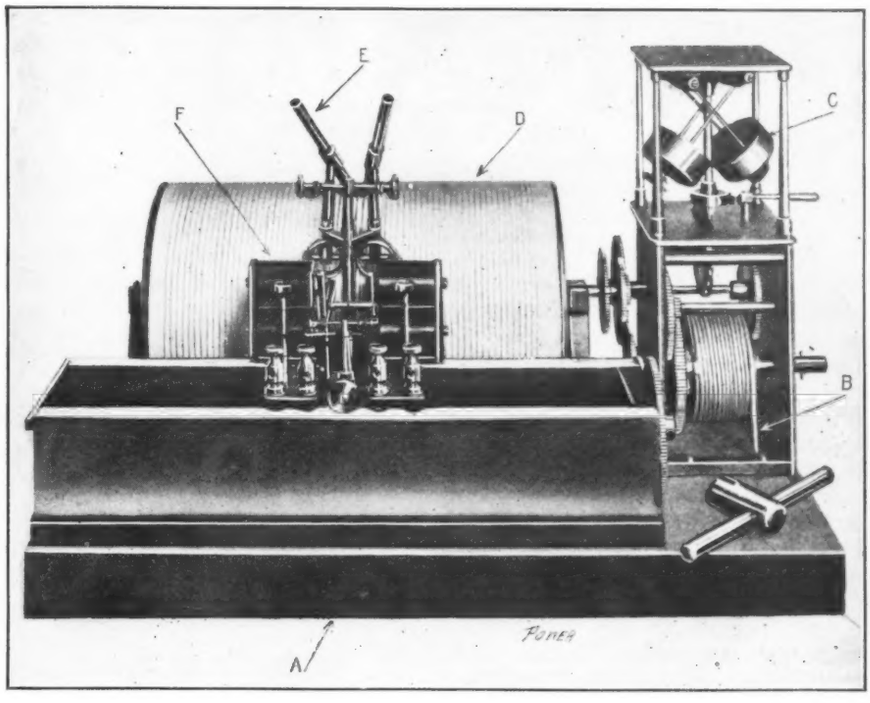


FIG. 4. CHRONOGRAPH

graph with speeds marked over the corresponding spaces.

To determine the exact stroke upon which the test is started, a small brass screw was tapped into the bottom of the drum of one of the indicators, which

in revolving opens and closes the circuit of the make-and-break switch. The chronograph is therefore started as soon as the indicators are hooked up to the reducing motion. As the test may not be started for some few minutes after connecting the indicators, the second pen of the chronograph is connected in parallel with the indicator-pencil magnets.

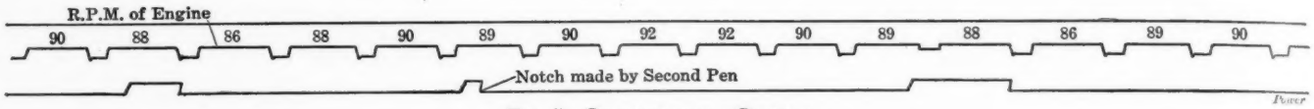


FIG. 5. CHRONOGRAPH RECORD

When the operator closes the switch and begins to take diagrams, the second pen of the chronograph will make a notch in the line. When the electromagnets operating the pencil are released, the chronograph pen resumes its free position and by the break in the line marks the completion of the test. The strokes indicated by the first pen and included between the notches made by the second pen therefore correspond exactly with the the number of diagrams on the continuous strips.

The electrical wiring of the system is of vital importance and is the one most apt to give the engineer trouble. Inasmuch as dry batteries were found unsuitable for the continuous operation of the indicators, it was deemed advisable to draw the power from the regular 220-volt, direct-current power mains. With this source of power all magnets of the same movement (that is all pencil magnets and all ratchet magnets) were wired in series and sufficient resistance inserted in the form of a bank of incandescent lamps. The number of lamps being determined according to the amount of current required for satisfactory operation.

In order to facilitate rapid connecting up of apparatus, a cable was made with suitable lengths of wire to fit any standard engine and the strands properly tagged at all connecting points.

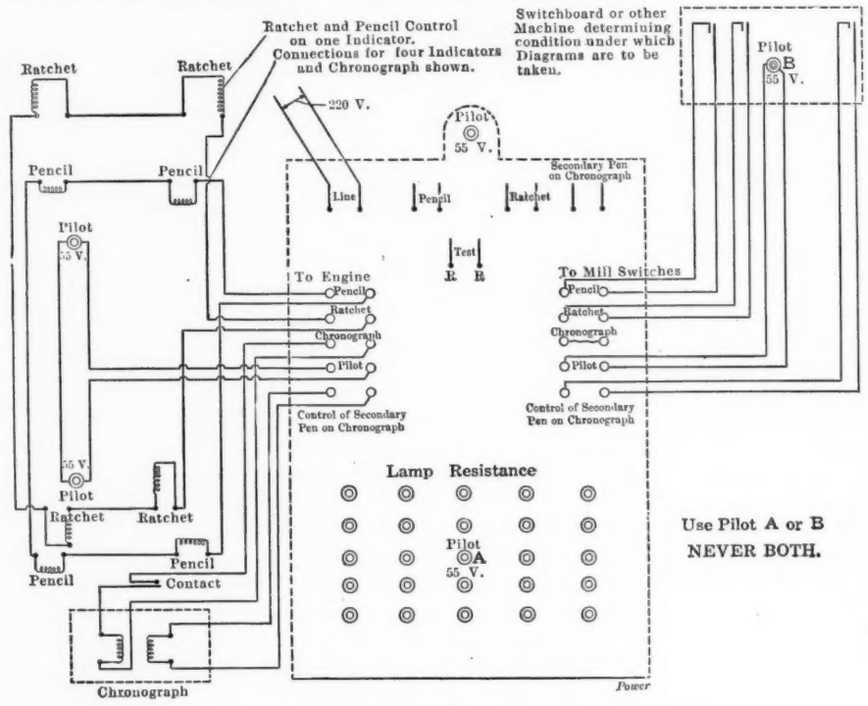


FIG. 6. DIAGRAM OF ELECTRICAL CONNECTIONS

Fig. 6 shows a circuit connecting four indicators and a chronograph with the necessary switches placed at the operator's station, and the necessary pilot lamps to show the assistant at the indicators when the test is started and stopped.

The lamps, fuses and switches are all mounted on a portable switchboard, the wiring of which is shown in Fig. 7. From this switchboard one cable carries the current to the instruments at the engine, and another cable leads to the master switches at whatever point the operator is stationed.

Inasmuch as direct-current power is not always available, a suitable and simple substitute for the above switchboard may be had in the form of a first-class automobile ignition battery of about 10 volts and 6 ampere capacity. The magnets should all be connected in parallel.

Continuous indicating has opened up a store of information never before attainable. Although requiring a considerable outlay of money, it is money well spent in the case of the larger power plants.

The theorem asserting that the deleterious influence of the clearance space is annulled by a compression to the initial pressure when the expansion is complete also, is not established except for the case where the law of compression is the same as that of expansion. It is not applicable to steam engines.—DWELSHAUVERS-DERY.

If my theory is correct, experiments made with a variable amount of absolute work following the degree of compression in such a way that the indicated work remains the same, should give the same consumption whatever the degree of compression.—B. F. ISHERWOOD.

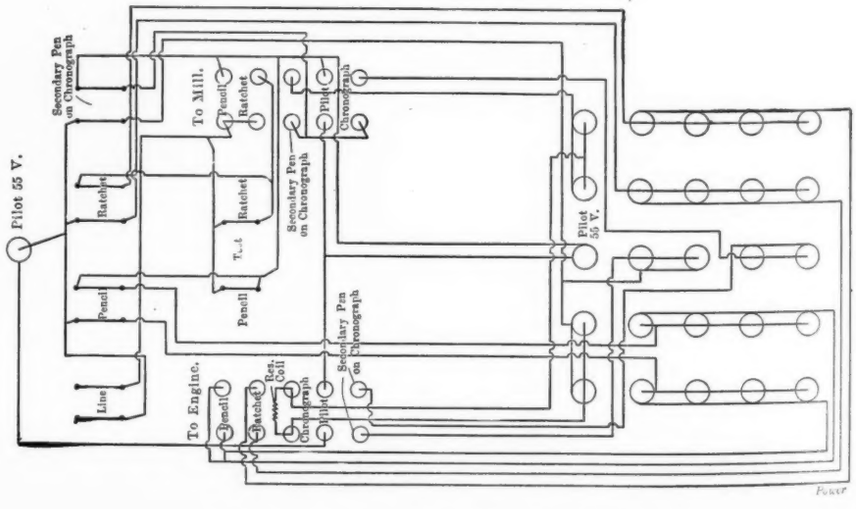


FIG. 7. WIRING ON PORTABLE SWITCHBOARD

The Fairview Pumping Station

By Thurlow E. Coon

What is known as the "Fairview District," in Detroit, is somewhat lower than the rest of the city, and as a result much difficulty has been experienced in properly draining it. To handle the drainage a new pumping station is being installed, and contains two engine-driven centrifugal pumps, each with a capacity of 100 cubic feet of water per second, supplemented by a motor-driven pump of 30 cubic feet capacity.

For several years past the city of Detroit has had considerable trouble in properly draining what is known as the Fairview district. This section is somewhat lower than the rest of the city and it became necessary to consider plans for installing a system for raising the sewage from the lower levels up to a point where it could be properly drained. The proposition was submitted to Smith, Hinchman & Grylls, consulting engineers of Detroit, who, after investigating a number of pumping stations operating under similar conditions, finally decided upon a system similar to the one located at the Ninety-fifth and Erie street station, Chicago.

The conditions in Chicago required two centrifugal pumps, running at 72 revolutions per minute with a capacity of 110 cubic feet per second under a static head of 12 feet, and an additional pump with a capacity of 30 cubic feet per second under a static head of 14 feet. They are of the vertical-shaft type, direct-connected

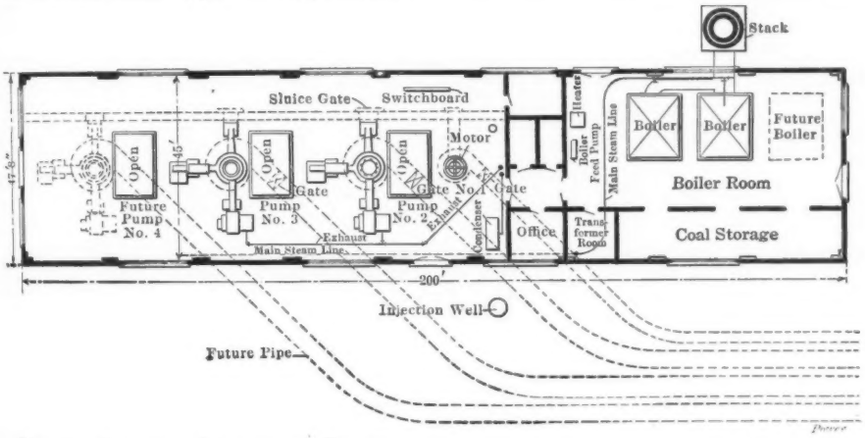


FIG. 1. GENERAL LAYOUT OF PLANT

to horizontal Corliss engines; each pump being provided with an independent suction and discharge pipe.

The consulting engineers found, however, that the conditions were much more

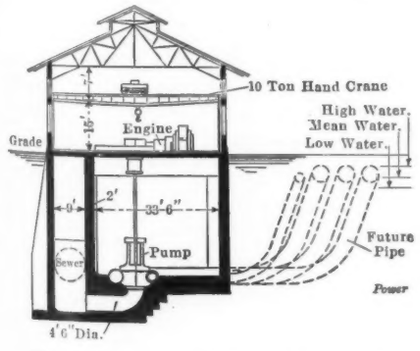


FIG. 2. SECTION THROUGH STATION

severe in Detroit than in Chicago and they therefore decided to install two engine-driven pumps each with a capacity of 100 cubic feet of storm water and sewage per second, against a normal head of 32.3 feet including friction, and an additional motor-driven pump with a capacity of 30 cubic feet per second delivered against a normal head of 30.3 feet or a maximum total head of 35 feet including friction. This latter pump is to take care of the ordinary conditions, the two larger ones to be used only in the time of flood.

The small pump is of the single-suction, vertical-shaft, submerged type, having a 26-inch suction opening on the under side and a delivery opening of 24 inches in diameter. It is driven by a 150-horsepower motor with a speed regulator so designed as to vary the speed from 330 to 353 revolutions per minute, according to the conditions.

The bearings are cast iron, carried on the top cover plate, and are lined with lignum vitæ. Suitable water circulation under pressure is provided for continuous lubrication and to free the bearing surfaces of any foreign matter.

The shaft is of open-hearth steel, extended through the bearing and fitted with cast-iron compression couplings. In order to facilitate erection or removal it is made in sections. A stuffing box is provided at the top of the pump bearing to prevent leakage from the pump casing.

There are three shaft steady bearings located between the pump and motor, these being mounted on horizontal spiders connected to cast-iron columns. The upper end of the intermediate shaft is connected to the lower end of the motor shaft by a slip coupling, permitting independent loading and adjustment of the pump and motor thrust bearings.

A suitable thrust bearing and mounting

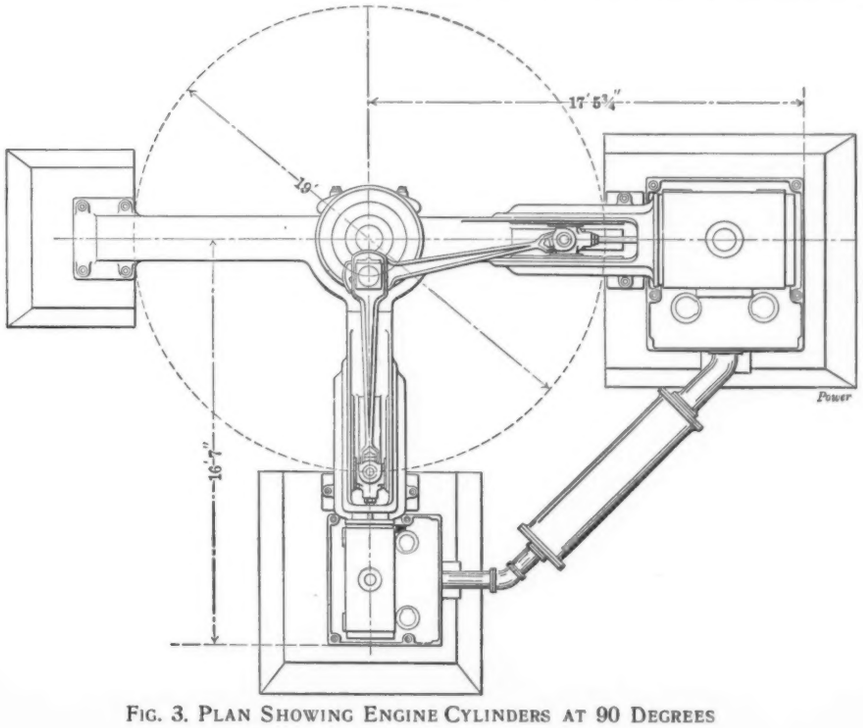


FIG. 3. PLAN SHOWING ENGINE CYLINDERS AT 90 DEGREES

for taking the weight of the revolving parts is located above the pump bearing.

The two large engine-driven pumps are similar to the motor-driven pump, just described, except that they are larger and of course, have greater capacity. Each of these pumps weighs approximately 30 tons including shafting, with a runner 10 feet 7 inches in diameter and has a suction opening 54 inches in diameter and a 42-inch delivery opening.

Fig. 1 shows a general layout of the plant, while Fig. 2 is a cross-section showing pump settings.

The two 18 and 36 by 36-inch cross-compound Corliss engines for driving these pumps are furnished by the Wisconsin Engine Company and have their high-pressure and low-pressure cylinders set at 90 degrees as shown in Fig. 3. They are guaranteed to develop 542 indicated horsepower at 100 revolutions per minute, using steam at 140 pounds gage and exhausting into 26 inches vacuum.

Among the special features of this type of engine is the valve gear which is of the liberating type, so designed that all strains are brought nearly in the same plane. All wearing surfaces are unusually large and the drop levers are placed within the bonnets and secured to the valve stems by keys and taper friction sleeves. This construction reduces the transverse strain on the valve stems to a minimum.

The connecting rod is a solid forging in one piece—no straps, gibs nor keys being used—the ends being slotted out square to receive the boxes. The latter are adjusted by means of a wedge and screw moving parallel to the axis of the pin.

The governor is of the high-speed type and may be regulated so as to give the engine any speed between the limits of 80 and 110 revolutions per minute.

The plant is now in the course of construction and will be completed shortly. It will be seen from the plan, Fig. 1, that provision has been made for installing another pumping unit of the same type and another boiler should the conditions at any time demand it.

Buying and Handling Coal in N. E.*

By J. S. Lawrence

Owing to the lack of systematic methods in buying and handling coal in New England, a yearly loss of millions of dollars is incurred. The writer points out the existing faults and suggests means of correcting them.

In 1908, the total coal consumption of New England was about 24,000,000 tons of 2240 pounds each, representing an expenditure of over $100,000,000. It is estimated that these figures show an increase of 100 per cent. over the coal consumption of 1898. Of this enormous quantity, approximately 8,600,000 tons were anthracite and 15,400,000 tons bituminous coal; 16,000,000 tons of the total being discharged at New England ports and 8,000,000 tons received by rail from the mines.

In the entire United States where the population and area approximate 5 per cent. of that of the globe, there is consumed annually over one-third of the world's total coal consumption.

The price of the best grades of bituminous coal at the mouth of the mine, has varied in the past six years from $1.60 to less than $1 per ton; some West Virginian coals being as low as 96 cents per ton. The average cost of carrying this coal to the New England consumer is about $2.50 per ton. The all-rail rates if plotted on a map, will be found to follow in general, the contour of the water line of New England, the highest point being found about 50 miles from the coast, due to the influence of tidewater carriage upon rates.

Owing to lack of standardization in methods of tidewater transportation, much unnecessary expense is involved, which might be obviated by a proper study of the conditions. Vessels vary so in type that a standardized loading plant is impracticable; the sailing vessel's cargo must be carefully trimmed, while the modern coal barge or steamer has its bins so constructed that little trimming is necessary. The unloading at destination points suffers from the same difficulty. Again, the arrivals of sailing vessels are irregular, and laden vessels frequently are obliged to lie in port for several days, awaiting their turn. With these conditions, unloading plants are at times forced beyond their economic capacity, while at other times they remain idle. In spite of this, a large percentage of our water-borne coal is carried in sailing ships, which, although cheaply operated themselves, introduce other large factors of expense.

Due to this irregular unloading, the railroads of New England cannot be expected to keep sufficient equipment at hand to meet the demands of the busy days, hence cars often not adapted to the purpose, must be used. This, combined with the lack of standardized unloading facilities at the plants themselves, is responsible for the frequent long demurrage on cars.

To obviate these evils the writer suggests the following remedies:

1. The establishment of a standard for coal-carrying vessels and for their loading and discharging plants.

2. The use of only such types of vessels between these standardized plants as can maintain a regular schedule.

3. The establishment of standard unloading plants to facilitate the prompt unloading of cars and a standard railroad equipment adapted to meet the more regular demands.

4. Careful study by experts as to the burning of coal and experiments to ascertain which kind produces the best results.

In connection with the last remedy suggested, it might be remarked that the selection of coal is too often made upon the fireman's recommendation without a proper study of the conditions.

It would be desirable to form a representative New England commission to make a careful study of the subject and recommend some form of standard equipment with the idea that the changes might conform to a general scheme, in the same way that a far-sighted manufacturer would lay out his plans and property.

In this respect the situation at Hamburg, Germany, is interesting. A number of steam producers formed an association for the study of their fuel supply, and employed experts for testing the fuels, experimenting with various modern methods of firing and with the subject of smoke reduction; the object being to obtain the highest possible efficiency. With this system, all plants are examined, their individual needs studied and recommendations made, and the firemen and buyers educated up to the most economical ways of performing their duties. This, it is claimed, has accomplished a great saving and each plant is well pleased with the coöperative work.

Where a tangible saving of this kind can be made, a large part of it usually accrues to the consumer. Of New England's enormous coal bill—$100,000,000, which at the present rate of increase will probably reach $200,000,000 in 1920—a small per cent. in saving would amount to millions of dollars in a year. A 5 per cent. reduction would have meant a saving of as many million dollars in 1908.

*Abstract of paper delivered at the annual meeting of the National Association of Cotton Manufacturers, at Boston, April 27-28, 1910.

The Carroll Patents

John E. Carroll claims that carbonic-acid gas is a source of vast energy, and that he has found out how to develop it. The circular or prospectus issued by his underwriters says that his inventions are fully covered by patents issued or pending.

The CO_2 Development Company, which is the name under which Carroll played the game in Philadelphia in 1907, went into the hands of a receiver, and there are several poorer but wiser citizens of the city of brotherly love who are patiently waiting for the trial of the said Carroll upon the indictments growing out of that exploitation.

The following extract from a letter written to the editor of POWER by C. J. Hepburn, the lawyer who defended him when he was sued for libel for exposing the CO_2 fraud, will throw some light upon the patent situation.

"As to your request for such information that I may have about the patents issued to him (Carroll), I would say that the only letters patent issued to him of which I have information is No. 847,995, the insulated pipe, to which you have already referred, but a memorandum of Carroll's operations with the CO_2 Development Company may be of interest in the premises.

On February 4, 1907, J. E. Carroll sold to the CO_2 Development Company, for $10,000,000 in its stock, his rights under application for four patents relating to his CO_2 apparatus. Three of these applications were rejected, and only one patent relating to an insulated pipe was issued. A careful search of the records reveals only one other patent issued to Carroll, but this has to do with an arrangement of propellers for a motor boat. No patents on the CO_2 motor have been issued.

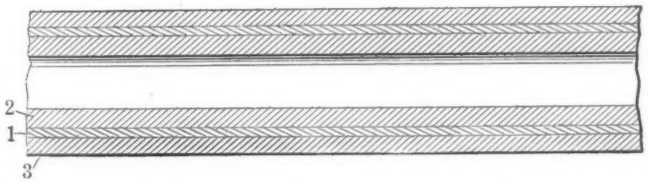


FIG. 1. INSULATING PIPE

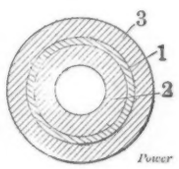


FIG. 2

"It appears that, at a special directors' meeting of that company, held February 4, 1907, Carroll sold to that company, for $10,000,000 in its stock, his rights under applications for United States letters patent Nos. 356,638, 356,639, 356,640 and 366,235. In consideration of that sale, certificate No. 1 of the company was issued to J. E. Carroll for 399,995 shares of the total par value of $9,999,845. The balance of the purchase price, as I remember it, was made up by the certificates of stock issued to the incorporators of the company.

"The peculiar fact, in connection with this sale, aside from the large price paid, was that none of these applications had been even filed in the United States patent office at the time the sale was made. A blank was left in the minutes of the meeting which was later filled in with the numbers of the applications after they had been actually filed. The first three applications above mentioned were filed February 9, 1907, and the fourth on April 3, 1907.

"Application No. 356,638 was that for the insulated pipe, for which letters patent No. 847,995 (which you have referred to) was issued March 19, 1907. All of the other applications were rejected and repeated amendments were also rejected. The history of these applications follows:

Application No. 356,639: Nest of Tanks, etc. (His so called CO_2 engine):

Application: February 9, 1907	Rejected: March 6, 1907
Amended: March 26, 1907	
Sup. Amend't: April 12, 1907	Rejected: April 22, 1907
Amended: May 9, 1907	Rejected: June 22, 1907
Amended: July 19, 1907	Rejected: September 9, 1907

(*Note:* The above application was assigned to the CO_2 Company, March 17, 1908, after its first rejection and prior to first amendment.)

Application No. 356,640: Gas-demonstrating Apparatus:

Application: February 9, 1907	Rejected: March 13, 1907
Amended: March 29, 1907	Rejected: April 5, 1907
Amended: May 2, 1907	Rejected: May 18, 1907
Amended: May 11, 1908	Rejected: May 26, 1908

(*Note:* The "gas-demonstrating apparatus" above mentioned was, I think, a gas tank with a plate of glass set in for the purpose of inspecting the interior while in use. It was assigned to the CO_2 Company, March 17, 1908, after first rejection and prior to first amendment.)

Application No. 366,235: Improvement in Means for and Method of Dehydrating Carbonic-acid Gas.

Application: April 3, 1907	Rejected: April 25, 1907
Amended: April 22, 1908	Rejected: June 1, 1908

(*Note:* This was assigned to the CO_2 Company, June 13, 1908, after final rejection.)

"So you see that the CO_2 Company received for its $10,000,000 stock issue simply the letters patent for the insulated pipe. These facts should compare well with the public statements and advertisements of Carroll made at that time, full information as to which you have.

"I have not the original patent records in my possession, they having been returned either to the receiver of the company or to Mr. Miller. But the above is taken from my brief made in connection with the libel prosecution here and you may rely upon it as being correct."

A careful search of the patent records up to May 17, 1910, fails to disclose any patent issued to John E. Carroll, except one for a piece of insulated pipe, and the other for an arrangement of propellers on a motor boat; not much to base a ten-million dollar company upon, and neither referring to the development of power from carbonic-acid gas. Descriptions of the patents follow:

PATENT FOR INSULATED PIPE

"This invention relates to gas-demonstration apparatus, the object of the present invention being to produce a pipe or conduit for gas which will protect the gas passing therethrough from freezing by the exclusion of atmospheric temperature from the inside of the pipe or conduit, and preventing the precipitation of moisture on the outer surface of the pipe or conduit.

"The pipe or conduit hereinafter particularly described is especially adapted for carbonic-acid gas, which will ordinarily freeze in its passage through the usual piping, being also equally well adapted for other highly volatile liquids.

"With the above and other objects in view, the nature of which will more fully appear as the description proceeds, the invention consists in the novel construction, combination and arrangement herein fully described, illustrated and claimed.

"In the accompanying drawings, Fig. 1 is a longitudinal section through a pipe or conduit embodying the present invention. Fig. 2 is a cross-section through the same.

"The conduit contemplated in this invention comprises a pipe 1, of metal, which pipe may be of any desired size and gage or thickness and of any length.

"In carrying out the present invention the said pipe is provided with an insulating lining 2, of fiber, which under the

preferred embodiment of this invention is vulcanized. For example, said fibrous lining may be composed of paper pulp made tough and waterproof by treatment, including pressure. The entire inside surface of the pipe 1 is protected by the fiber lining 2, and thus acts as an armor to keep the outside atmospheric temperature from reaching the center of the pipe or conduit and causing the gas passing therethrough to freeze.

"In addition to the inside fiber lining, the pipe 1 also has an outside covering or jacket 3 applied thereto, the said outer covering or jacket consisting of the same or similar material and fitting closely around and lying in contact with the outer surface of said pipe. Such outer covering is auxiliary or supplemental to the inner lining.

"The fiber lining and covering or jacket

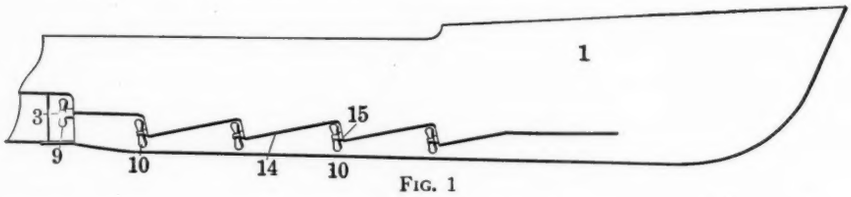


FIG. 1

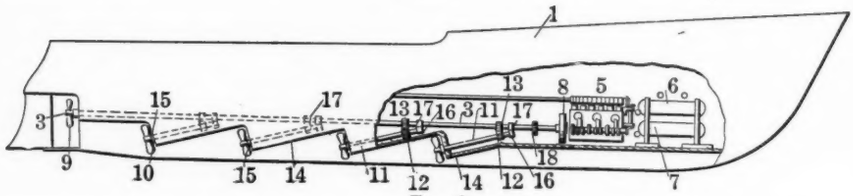


FIG. 2

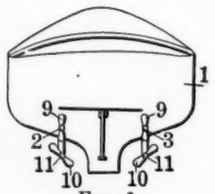


FIG. 3

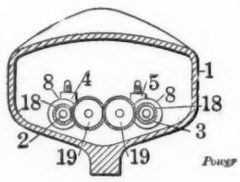


FIG. 4

are excellent nonconductors of heat and cold and effectively insulate the bore or central passage through the same, preventing congealment of the atmospheric moisture upon the outside of the conduit.

"I claim:

"A gas conduit embodying a pipe, a fiber lining therefor, and a fiber covering or jacket around the pipe, substantially as described."

JOHN E. CARROLL.

BOAT-PROPELLING APPARATUS

"This invention relates to propelling apparatus for boats, the object in view being to provide in connection with an engine driven by carbonic-acid gas or gas of a similar nature means actuated by said engine for propelling the boat and at the same time producing a lifting action on the hull of the boat so that the actual displacement and wetted surface of the hull, while in motion, will be materially reduced, and whereby the power developed by the engine will drive the hull along at a comparatively high speed as compared with a boat in which no provision is made for lifting the hull as it is propelled.

"With the above and other objects in view, the nature of which will more fully appear as the description proceeds, the invention consists in the novel construction, combination and arrangement of parts as hereinafter fully described, illustrated and claimed.

"In the accompanying drawings, Fig. 1 is a side elevation of a boat having the improved propelling apparatus applied thereto. Fig. 2 is a side elevation of the same partly broken away in section. Fig. 3 is a stern elevation of the boat, and Fig. 4 is a vertical cross-section through the same.

"The hull of the boat above the water line may be of any usual or preferred type and is indicated at 1 in the drawings. Under the preferred embodiment of this invention twin shafts 2 and 3 are provided, the same extending lengthwise of the boat, parallel to each other and at a suitable distance apart. At their rear ends each of said shafts is provided with a propeller 9 and the shafts may be geared to run either in the same or in opposite directions, preferably the latter. At their forward ends the shafts are coupled to one or more engines or motors indicated at 4 and 5. Preferably two of such engines or motors are employed, one for each shaft, the said engines being supplied with gas from any suitable number of cylinders or tanks 6 and 7, placed at any convenient point or points in the boat, as shown. Each engine shaft is also shown as provided with a flywheel 8.

"The propellers 9 at the rear ends of the shafts 2 and 3 are placed directly upon said shafts and driven directly thereby in the usual manner, but in addition to the propellers 9, which are used for driving the boat lengthwise, I employ series of auxiliary propellers 10, two of such series being utilized, one series on each side of the vessel, as indicated in Figs. 1, 2 and 3. The propellers 10 operate both to drive the boat lengthwise and also to elevate or raise the hull of the boat and for this purpose the shafts 11 of each and all of the lifting propellers are set at a considerable angle to the horizontal as clearly shown in Figs. 1 and 2. Each shaft 11 is provided with a gear wheel 12, which meshes with a corresponding gear wheel 13 on the adjacent long shaft 2 or 3, as the case may be. All of the side shafts 11 are thus geared to the two main shafts 2 and 3, and in this way motion is simultaneously transmitted to all of the propellers, any number of which may be employed, according to the size of the boat and the speed required.

"In order to properly house in the shafts of the side or lifting propellers, the hull of the boat is provided with a number of depending wedge-shaped offsets 14, which are cored out to receive the shafts 11 and provided with stuffing boxes 15 at the rear, through which the shafts pass. In addition to the bearing afforded by the stuffing box, each of the side shafts may be supported at its forward end in a bearing 16, secured within the hull of the boat in any approved manner, and said bearing 16 may be of such shape as to form also a bearing 17 for the main shaft with which the auxiliary shaft is connected and by which it is driven, as shown in Fig. 2.

"While each engine is an independent motor, it is preferred to gear the two motor shafts together or provide means by which this may be accomplished, as shown in Fig. 4, in which it will be seen that one or more intermediate transmission gears are interposed between the twin shafts so as to mesh with wheels or pinions 18 on said shafts, 19 designating such interposed gear wheels. Any suitable shifting device may be used for shifting the intermediate gear wheels into and out of mesh with the wheels 18 on the shafts 2 and 3. In this way, should one of the engines or motors stop or require to be stopped for repairs, both of the main shafts could be coupled together so as to be actuated by the one engine and thus all of the propellers would be driven, notwithstanding the fact that one motor was out of use.

"The number of engines or motors may be varied at will and likewise the number of propellers, stern and side or lifting, according to requirements, without departing from the principle or sacrificing any of the advantages of the invention.

"I claim:

"1. Propelling mechanism for boats, comprising a fore and aft motor-driven shaft, a propeller mounted thereon, inclined auxiliary shafts geared to said motor-driven shaft at intervals in the length thereof, and propellers on said auxiliary shafts.

"2. Propelling apparatus for boats comprising a main shaft, a motor for actuating said shaft, a propeller driven directly by said shaft, and auxiliary shafts set at an inclination to the direction of movement of the boat and geared to the main shaft and provided with propellers which act to elevate the boat as it is driven lengthwise.

"3. A boat hull provided with depending inclined offsets along the bottom thereof, in combination with propelling apparatus comprising a main shaft, a propeller driven thereby, auxiliary shafts mounted at an inclination in the said offsets and geared to the main shaft, and propellers on said inclined auxiliary shafts.

"4. Propelling apparatus for boats comprising twin shafts, a motor for each of said shafts, a propeller on each shaft, lifting propellers geared to and actuated by said shafts, and means whereby one of said shafts is adapted to drive the other shaft, substantially as described."

JOHN E. CARROLL.

Engineering Building for Boston

Not to be outdone by their New York associates, the engineering and scientific societies of Boston have joined forces in a proposition to erect an eight-story building to contain their headquarters and an engineering club. The plans of the proposed building are herewith submitted.

Several of the scientific and technical societies of Boston have formulated a plan to erect a joint engineering club and societies' headquarters building along similar lines to the one now built and operating successfully in New York City.

It is believed that by having the club and societies' building in one, each branch will benefit the other; the club will make the offices and rooms of the society more desirable, while, in turn, the occupants of the society rooms will make the business of the club more desirable.

Those having the proposition in hand have gone so far as to have Wheelright & Haven, Boston architects, submit plans for the proposed building. These plans are herein reproduced, and show that much thought and consideration have been given toward having them meet the prospective requirements.

As planned, the building will be divided into practically two halves; the club part and the office or society section; the former to face on a residential street and the latter on a business street. The club proper will contain all the usual appointments, including bowling alleys, plunge, showers, etc., in the basement; ladies' dining room, members' reading and writing room and coat rooms on the first floor; and members' smoking room, billiard room and grill room on the second floor. The other half of these floors will be devoted to shops and offices.

The third, fourth, fifth and sixth floors are given up entirely to sleeping rooms and offices, of which there are sixty-four of the former and eighty-four of the latter of an average size of 18x20 feet.

The seventh and eighth floors contain dining rooms, kitchen, card rooms and a

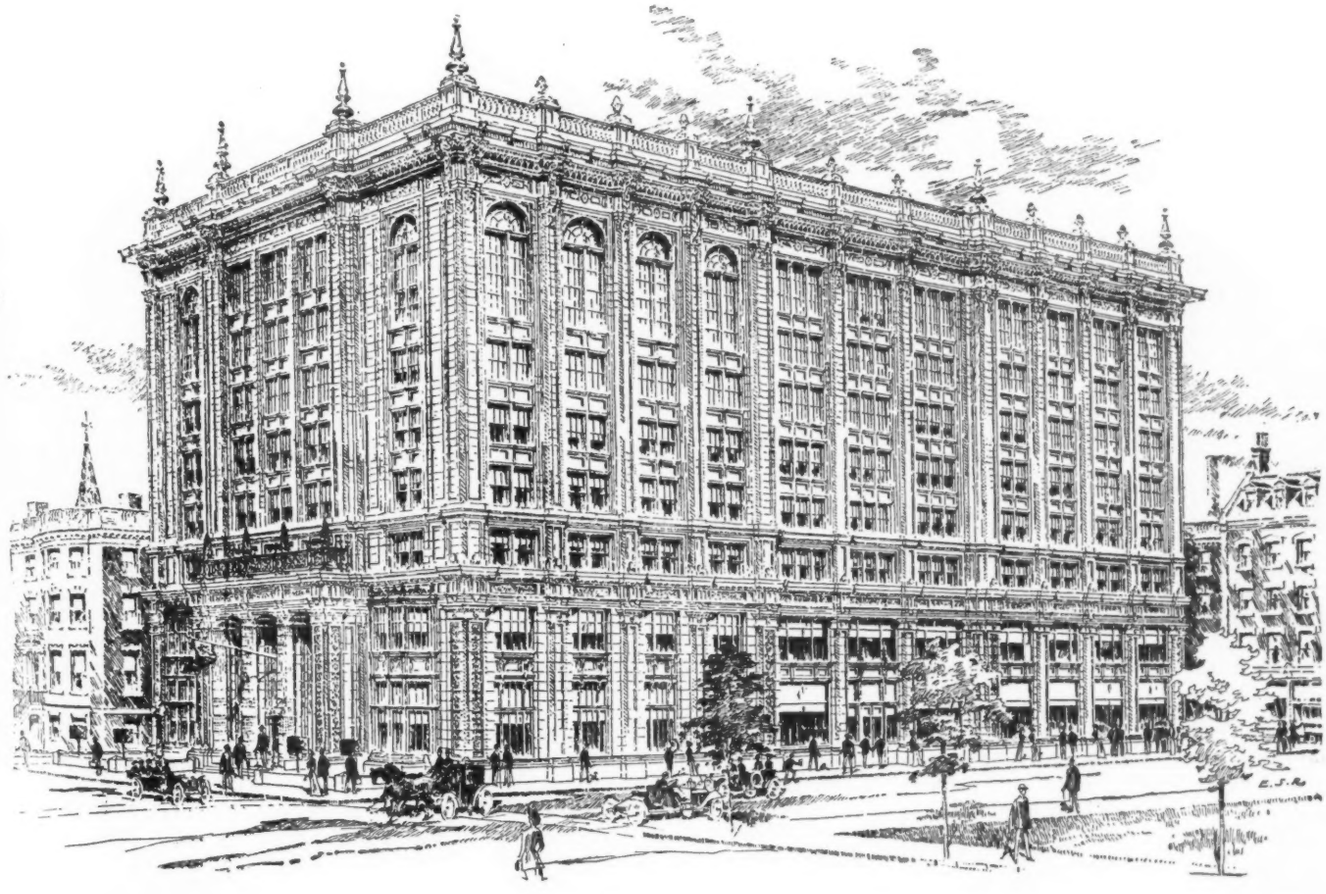


FIG. 1. EXTERIOR VIEW OF PROPOSED BUILDING

FIG. 2. PLANS OF THE VARIOUS FLOORS

banquet room for the club members; while for the use of the various societies there are a library and a number of meeting rooms.

Special attention has been given throughout to afford the maximum amount of daylight to all rooms.

It is proposed to select the membership, so far as possible, from the members of the engineering, architectural and scientific professions, with an initiation fee of $50 and annual dues of like amount for resident members, and one-half these amounts for nonresident members.

As it is desired to form an estimate of the possible membership in the proposed club, those interested are solicited by the secretary, L. S. Cowles, 101 Milk street, Boston, to send in their views on the club and an expression with regard to membership.

Steam in a Cold Boiler

By R. O. Richards

I was present at the boiler room of a small electric-lighting plant one Sunday afternoon while a return-tubular boiler was being tested under hydraulic pressure. Alongside this boiler and connected to it by steam piping was another boiler of the same type, which at that particular time was under 110 pounds steam pressure. The service supplied by the plant was such as not to require the running of the engines during daylight on Sundays, consequently the temperature of the water entering the boiler under test was somewhere about 45 degrees, the weather at the time being cold. The test being concluded, the blowoff valve was opened to relieve the boiler of the pressure, and to bring the water to a proper level for starting the fires. To the astonishment of everyone present, steam was discovered escaping from one of the water-column try cocks which was opened. At first it was surmised that water had been let out of the boiler so fast that the small spring-tension vacuum valve on top, could not admit air fast enough to prevent a partial vacuum being formed, and someone had read that cold water will boil in a vacuum. Later, however, it was discovered that the metal disk of the gate in the connection between the two boilers, had split, the difference in temperature between its two faces having been too great for it. Hence steam was admitted from the other boiler.

Operating Costs of Large Units

The increasing demand for power within the past few years has been met by the design of large steam turbines. In this respect, however, boiler practice has not kept pace; that is, the capacity of the individual unit has not been correspondingly increased. An advance in this direction has recently been made by the Commonwealth Edison Company, of Chicago, two of whose plants are herein considered with regard to boiler setting and the cost of power production per kilowatt-hour.

Great centers of population, such as our American cities, offer the best of opportunities for the development of large and economical power-generating stations. It is here that there exists a constant demand for current in enormous quantities. The lighting load, which was the first and at one time the only avenue for the disposal of electric current, is now being surpassed by the power and traction loads, which tax the capacity of our largest stations. One of the most important questions with regard to central-station service is the load factor. Large cities, with their multiplicity of interests continually using current in one form or another, can be depended upon to furnish a field which, when properly cultivated, results in a satisfactory station load at all hours.

Furthermore, it is inevitable that as communities grow and become educated to better conditions, the electrification of all traction facilities within their borders will become an accepted conclusion and we will then see grouped together immense aggregations of power such as, up to the present time, have only been possible in a few instances.

Slow Progress in Steam Making

To meet the development which has already taken place, turbines have increased in capacity at a rate which has easily kept pace with the increased demand for power, but boiler practice, particularly with respect to capacity, has lagged behind, and is far outdistanced in output per unit by the rapid development of the machines to which it supplies motive power.

This, perhaps, has not been due so much to the boiler itself, it long having been known that we have not worked our heating surfaces to their maximum capability, but rather to the problem of burning great quantities of coal in one furnace and obtaining brickwork to withstand the necessarily high temperatures involved. The question of burning coal is indeed a serious one, especially if it is expected to maintain economy. When large power is being developed, the rate of combustion, due to the correspondingly heavy draft, must of necessity be high, so that if great care in design is not exercised we obtain capacity at a sacrifice of economy. An instance of this is found in the modern steam locomotive, which, while burning enormous quantities of coal in a limited area, also wastes a considerable percentage of unburnt fuel in the stack. Although in stationary practice there is no danger of duplicating this particular loss, still there is a chance of introducing a similar one by the drawing of excess air through or around the fire when consuming large quantities of coal per square foot. However, it may be said that mechanical stokers have done much toward the solution of this question and, if properly arranged, one fireman can attend to the output of a large amount of horsepower.

Firebrick a Difficult Problem

The other phase of the problem, that of the firebrick, may never be entirely settled. However, it has been stated by combustion experts that it is commercially permissible under certain conditions to force the furnace fires to the limit, burning out brickwork as fast as necessary, provided the resulting capacity realized from the boiler is sufficiently high. According to this doctrine, increased capacity means less first cost of the boiler plant, subsequently low fixed charges, and other advantages great enough to offset the expense of periodically replacing refractory material in the furnace. One of the important results to be obtained by this practice is the remarkable reduction in attendance per unit of output, which has the effect of greatly reducing the operating costs for this item.

Investigations of the subject have brought out the fact that as far as the boiler itself is concerned, this overcrowding can be done without appreciable decrease in efficiency; and in some cases it has been claimed that an actual increase of overall efficiency may be obtained.

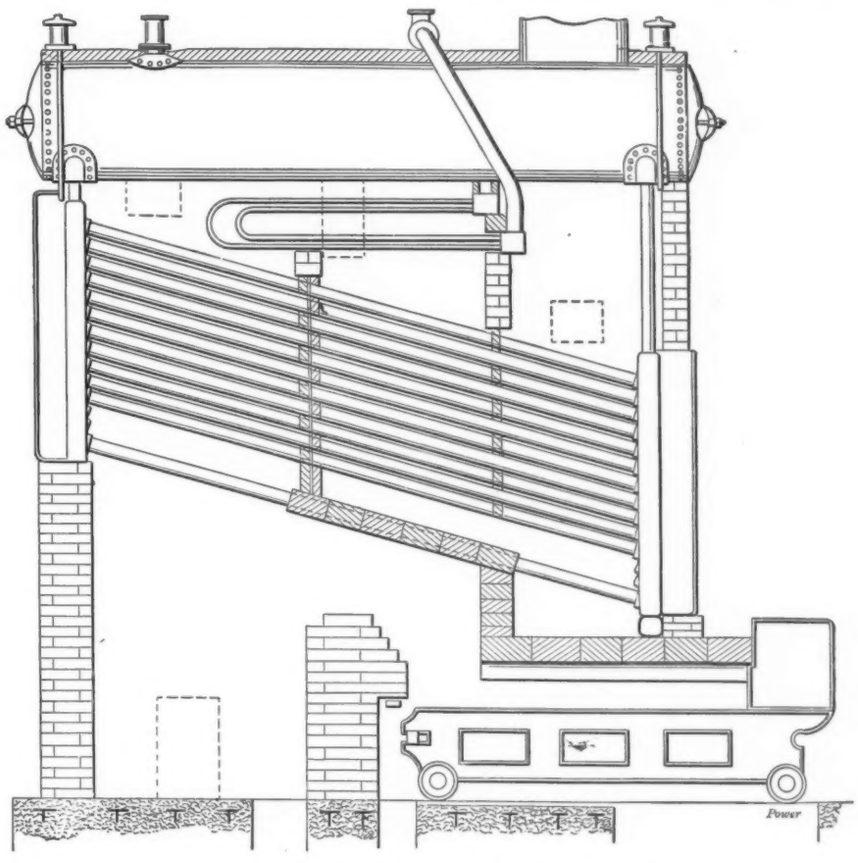


Fig. 1. Boiler Setting at Quarry Street Station

Perry's Theory

These researches have verified to a notable extent the conclusions which Prof. John Perry reached several years ago in regard to the transfer of heat through boiler surfaces. Perry's idea, based upon the ac-

cepted theory that heat is a mode of motion of the molecules composing a body, was to the effect that the faster the gases are passed over the heating surfaces of a boiler, the more rapid and more efficient will be the transfer of heat. In explanation of this theory it was held and mathematically demonstrated that the outer molecules of the heating surface became entangled with the molecules of the hot gases, which promptly gave up their heat and remained as a film of nonconducting material through which it is difficult for additional heat to pass. A very rapid circulation of the gases, it was claimed, would have a scrubbing action, cleaning this film of nonconducting gas from the tubes of the boiler and allowing the fresh hot gases from the fire to come in contact with the heating surface, thus resulting in a greater amount of heat per unit area being transferred to the water.

All of this is in direct variance with the old school of boiler practice, which calls for a large grate area, slow rate of combustion and slow passage of the gases over the heating surfaces.

Perry predicted that boilers would eventually be worked at many times the rate of evaporation which was then, and still is, standard practice. Although his work passed unnoticed for years, it indicated the lines along which future boiler development will surely take place.

One of the notable instances of boiler practice following the lines above suggested is to be found at the Quarry Street station of the Commonwealth Edison Company, Chicago. The practice here is an outgrowth of what has been found possible and desirable at the Fisk street station and has taken place not from a desire to verify any theory, but from the pressure of commercial considerations. With the 14,000-kilowatt turbo-generators here installed, the necessary boiler plant would, on the ordinary basis, have been absolutely unwieldy and impossible from the standpoint of space occupied. It is a fact that commercial considerations have had more to do with developing types of power equipment than all the engineering theories in the world.

Practice at Quarry Street

The present building, which is soon to be doubled in capacity, occupies a ground space of 208x270 feet, and contains three 14,000-kilowatt, five-stage, vertical, Curtis turbines, driving four-pole, General Electric alternators at 750 revolutions per minute. Each turbine rests on a Worthington surface condenser having 25,000 square feet of cooling surface, with the usual auxiliaries, including Corliss engine-driven centrifugal circulating pumps, oil pumps for step bearings and feed pumps for the corresponding battery of boilers. The plant is laid out on the unit system, eight boilers, placed four in a row, on each side of a central aisle furnishing the steam for one turbine. The coal is handled entirely by mechanical means and is elevated to individual hoppers of 150 tons capacity, situated over each boiler, and feeds by gravity to the stokers below.

Interest centers in the boiler room as the place where standard practice has to a great extent been departed from. The boilers are all of the Babcock & Wilcox water-tube type, each containing 5000 square feet of heating surface. They are designed for a pressure of 225 pounds gage, with a maximum steaming capacity of 35,000 pounds per hour, superheat of 150 to 175 degrees being carried. The equipment also includes chain-grate stokers, having a length of 8.5 feet and a width of 11.5 feet, giving 97.75 square feet of grate surface, or a ratio of grate to heating surface of 1 to 51.

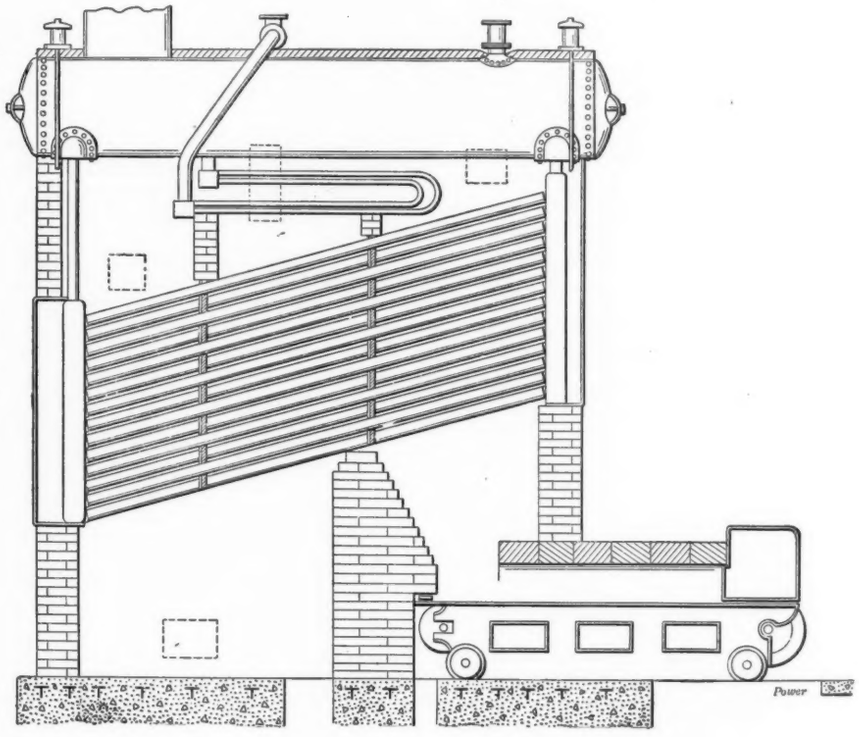


Fig. 2. Proposed Setting for New Station

The settings do not follow the ordinary arrangement as in the Fisk street station, but have the stokers installed under what would ordinarily be the back end of the boilers, with the combustion arch directly under the mud drum. The gases pass to the opposite end of the boiler under a tile roofing over the lower row of tubes, before encountering the heating surface. The superheater is located in the ordinary manner and the gases make three vertical passes through the bank of tubes before passing to the self-supporting steel stacks, 12 feet in diameter and 250 feet high. Fig. 1 shows the general features of the setting.

This setting was designed to give a large and expanding combustion chamber in which to mix and burn the gases before coming in contact with the boiler tubes, as it was feared that without this the hot gases striking the upper end of the inclined tubes might reverse the direction of circulation when the boilers were forced.

The setting has been criticized on the ground that it must be set 4½ feet higher than the ordinary setting, necessitating greater head room, greater first cost, greater expense of maintenance and more radiation and leakage. Also it has been said that the disposition of the firebrick tiling, slanting upward as it does, will not provide for a thorough contact of the gases with the brickwork and the consequent mixing necessary for efficient combustion. It has also been pointed out that with the combustion arch surrounded with hot gases on both sides it will be short lived and repairs to the brickwork will be excessive, while any attempt to ventilate above the arch would introduce an air leakage tending to lower the boiler efficiency. It might be well to note that all these considerations have to do with the furnace end of the problem, which, as previously mentioned, is the most difficult, and do not refer to the boiler itself. The attempt here has been first to realize large capacity by forcing large quantities of hot gases through the boiler and incidentally to get what economy is possible. The statement has been made that it is impossible to burn economically 60 pounds of coal per square foot on a chain-grate stoker, owing to the enormous leakage of air over the bridgewall when using the heavy draft necessary under those conditions.

In this connection it is interesting to note that the proposed boiler settings in the new stations of the Commonwealth Edison Company, while retaining the chain-grate stoker, will have the boilers turned back to the normal position, following the practice at Fisk street, with the exception that they will be set higher, as indicated in Fig. 2.

So much for the combustion problem. A consideration of what the boilers themselves are doing when being forced to large capacities is interesting and instructive when used as a comparison with the rate of working found in ordinary practice.

Large Steaming Capacity

With eight boilers of 5000 square feet of heating surface each, making a total of 40,000 square feet, furnishing steam to one turbine developing 14,000 kilowatts, a kilowatt will be generated by

$$40{,}000 \div 14{,}000 = 2.85$$

square feet of heating surface, or a horsepower by 2.13 square feet, which is considerably less than the 10 square feet allowed by the ordinary boilermakers' rating. Again, by evaporating the 35,000 pounds of steam per hour per boiler, the evaporation will be seven pounds of water per square foot of heating surface.

It has been said that 65 per cent. of all the evaporation in a boiler takes place in the first passage of the gases through the bank of tubes. On this basis, assuming that the first passage contains 40 per cent. of the total heating surface, the evaporation when steaming at full capacity would be 11.3 pounds of water per square foot of heating surface in this part of the boiler, which is probably not far from the truth in this case; so that with the economical water rate realized by the large turbines, an electrical horsepower would be delivered by less than one square foot of heating surface.

By these figures it can be seen that the rate of steaming in these boilers is much in excess of that met with in regular practice and indicates something of the possibilities along this line.

Typical Operating Costs

For the purpose of showing the influence upon operating costs of these large-sized units and high rate of output, let us assume a typical case. Consider one boiler and turbine unit out of six in a large power station, and figure the costs which might reasonably be expected in a plant of this size.

As for the economy, the turbines have been reported before the American Institute of Electrical Engineers as developing a kilowatt-hour on 12.8 pounds of steam. The record rate at Fisk street is given as 12.94 pounds, and as the principal difference between the units in the two stations is in the rating of the generators, the steam ends being practically identical, not much better performance could be looked for.

Sixty-five per cent. will be taken as the load factor, it being assumed that with the opportunities at hand, if the load should get below this point on any machine the other generators in use will be able to take over its load, and the underloaded machine can be shut down entirely. This load factor is not based on the maximum possible output of the machines, but on the regular rated capacity. It is frequently said that one of the greatest disadvantages of the gas engine is its slight overload capacity, and the tendency in steam-turbine practice to figure the load factor on the maximum output seems to be a deliberate attempt on the part of the turbine people to assume a disadvantage against which the gas engine has long been struggling and which is not inherent in the steam proposition. At an economical load factor, with 65 per cent. as the minimum, the steam consumption should not be far from 13 pounds per kilowatt-hour, and if 5 per cent. of all steam generated goes to the auxiliaries there will necessarily be a total of

$$\frac{13 \times 100}{95} = 13.68$$

pounds of steam per kilowatt-hour for the station.

Current freight rates on coal show that the average rate per ton from the coal-fields to Chicago is about 80 cents, while published quotations indicate that 35 cents will buy the better grade of screenings at the mines, and lower grades can be obtained for somewhat less money. Adding switching charges, etc., will bring the total cost up to $1.20 per ton. The ordinary grades obtained in Chicago are of the cheap variety, having a heat value, as received, of about 10,430 B.t.u. per pound, and an average analysis as follows: Moisture, 12.79 per cent.; volatile matter, 32.40; fixed carbon, 33.77; sulphur, 4.13; ash (as received), 17.91 per cent.

Steam at 200 pounds gage pressure and 150 degrees superheat will contain 1290 B.t.u. per pound, assuming the specific heat of superheated steam at this pressure to be 0.60.

We have no reason for allowing more than 60 per cent. boiler efficiency and on this basis there will be evaporated

$$\frac{10{,}430 \times 60}{1290} = 4.85$$

pounds of water per pound of coal as fired, giving

$$13.68 \div 4.85 = 2.82$$

pounds of coal per kilowatt-hour, or 29,412 B.t.u. per kilowatt, including auxiliaries.

Certain losses are inevitable and would easily bring the total coal per kilowatt-hour up to three pounds.

At $1.20 per ton this amount of coal would cost 1.80 mills, representing the total cost of fuel per kilowatt-hour.

In the matter of wages, the following items would enter into the cost of power delivered by one unit to the switchboard:

GENERAL ENGINEERING FORCE.

One chief engineer at $250 per month, ¼ of his time	$1.40 per day
One assistant chief engineer at $200 per month, ¼ of his time	1.11 per day
One chief electrician at $200 per month, ¼ of his time	1.11 per day
One assistant chief electrician at $150 per month, ¼ of his time	0.83 per day
Three load despatchers at $100 per month, ¼ of their time	1.66 per day
One boiler room foreman at $100 per month, ¼ of his time	0.55 per day

OPERATORS FOR ONE GENERATING UNIT.*

Three watch engineers at $4 per day of 8 hours	$12.00
Three oilers at $2.50 per day of 8 hours	7.50
Three switchboard attendants at $2.50 per day of 8 hours	7.50
Three firemen at $2.50 per day of 8 hours	7.50
Three water tenders at $2.50 per day of 8 hours	7.50
One boiler washer at $2.50 per day of 8 hours	2.50
One pipe fitter at $3 per day of 8 hours	3.00
One pipe fitters helper at $1.50 per day of 8 hours	1.50
Four laborers at $2 for coal handling	8.00
Total	$63.66

*In the plant upon which these figures are based, there is a watch engineer and an oiler employed to look after each unit.

With a 65-per cent. load factor, corresponding to an output of 218,400 kilowatts per day of 24 hours, the wages would amount to

$$\frac{63.66 \times 1000}{218{,}400} = 0.291 \textit{ mill}$$

Allowing $25 a day for oil, waste, supplies, running repairs, etc., would increase the cost

$$25{,}000 \div 218{,}400 = 0.114 \textit{ mill.}$$

Summing up, the total operating cost per kilowatt-hour delivered to the switchboard amounts to:

Fuel	1.80 mills
Wages	0.291 mills
Supplies and repairs	0.114 mills
Total	2.20 mills

Similarly, the installation of such large-sized units in a station would have a marked effect on fixed charges due to the saving on real estate, buildings, etc. Complete turbo-generating stations of moderate capacity have been installed for $66 per kilowatt, but on the basis of $60 per kilowatt for this station, a simple calculation will show the estimated overhead costs on a rating of 14,000 kilowatts with 12 per cent. charges on the investment and an average daily output of 218,400 kilowatts, as follows:

$$\frac{14{,}000 \times 60 \times 0.12 \times 1000}{365 \times 218{,}400} = 1.26$$

mills per kilowatt-hour, making a total cost of a kilowatt-hour delivered to the switchboard, of 3.46 mills.

Electrical Department

The Electric Elevator

By William Baxter, Jr.

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Mechanical Control Equipment of the Eastern Machinery Company

The Eastern Machinery Company, New Haven, Conn., makes electric elevators with the various types of control generally used, and for both direct current and alternating current. The general appearance of the Eastern direct-current machine with mechanical control is shown in Fig. 103. The operating sheave is shown at *A*, and the frame of the stop motion at *A'*; the traveling nut which actuates the stop motion at the top and bottom limits of travel is at *A"*. This stop motion is substantially the same as those previously explained.

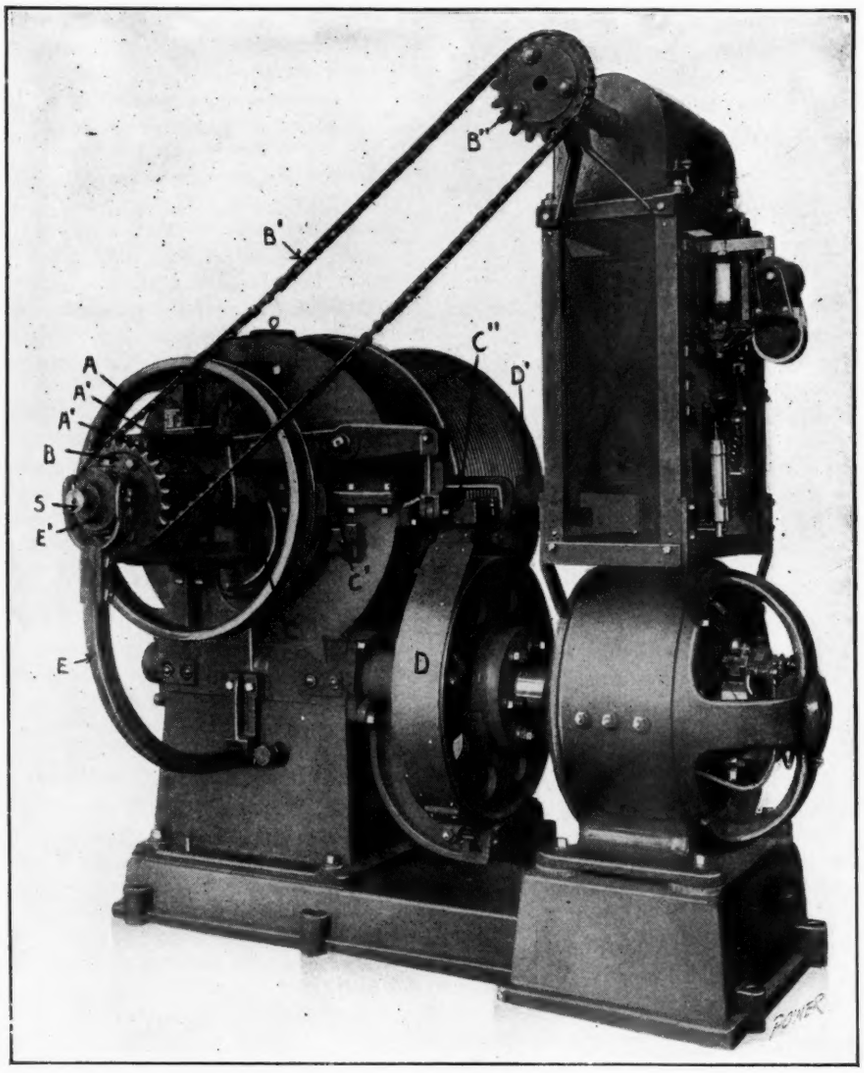


Fig. 103. Eastern Elevator with Mechanical Control and Automatic Acceleration

The sprocket wheel *B* is bolted to the outer end of the stop-motion frame, and through the chain *B'*, rotates the sprocket *B"*, mounted on the end of the drum shaft of the reversing and starting switch *R*, which is mounted on top of the controller box. As the stop-motion frame is secured to the side of the operating sheave *A*, it is evident that when the latter is turned in either direction the reversing switch is also turned, through the sprockets and the connecting chain. Back of the operating sheave can be seen an eccentric-shaped cam *C*, which is fastened to the side of the sheave and, therefore, rotates with it. This cam is shown in the "stop" position, but when the operating sheave is rotated to set the elevator in motion the cam *C* is also rotated and, no matter in which direction it may be turned, it will lift the lever *C'* and through the connecting lever *C"*, release the brake. Normally the brake straps are held against the brake wheel *D* by the weight *D'*.

The controller on this machine is one of the various types made by the Cutler-Hammer Company. It is more clearly shown in Fig. 104, where the reversing switch *R* is shown in a different position. The main line switch is shown at *S*, in Fig. 104, and it is arranged so that the circuit through its magnet coil is closed by the movement of the reversing switch. The result of this arrangement is that the reversing switch closes the contacts that complete the motor circuits before there is any current passing through them, and when the elevator is stopped, the main-line switch *S* is opened before the reversing-switch contacts separate. Consequently, there is no sparking at the the contacts of the reversing switch. All sparking of any consequence takes place at the contacts of the main-line switch *S*, and this is provided with a magnetic blow-out *A* to break the spark and pro-

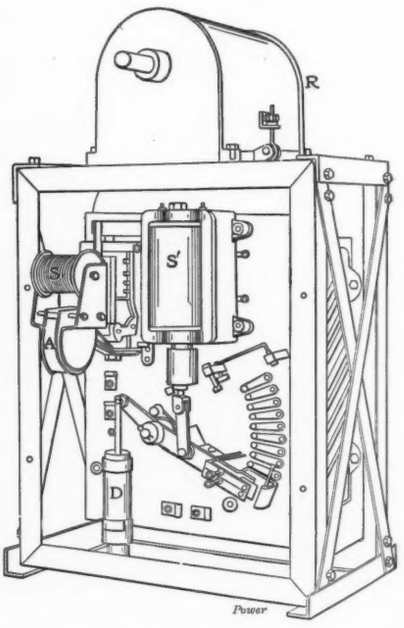


Fig. 104. The Controller of Fig. 103

tect the contacts. The solenoid *S'* acts to cut out the starting resistance, the velocity of the upward movement of the plunger being controlled by the dashpot *D*. The circuit connections for this type of controller were given in one of the articles on belted machines, and need not be repeated here.

The curved lever *E*, in Fig. 103, is a part of the slack-cable mechanism. This lever acts to move endwise of the drum shaft *S*, a clutch collar *E'* that slides on a feather on the shaft and rotates with it. The other half of this clutch is secured to the stop-motion frame, so that when lever *E* moves so as to throw the clutch into engagement, the stop motion, together with the sprocket *B* and the cam *C* are rotated, and in this way the reversing switch is returned to the "stop" position and the brake is released, so that it may be applied by the weight *D'*. The arrangement of the other parts of the slack-cable apparatus can be more fully understood from Fig. 105, which is a view of the machine from the opposite side, and also from the outline drawings in Fig. 106.

In Fig. 105 it will be noticed that there is a shaft *S'* at the center of which is a curved lever *S''*. This lever runs under the end of the lever *E*. On the shaft *S'* there are two side levers *F F* that run upward and forward, and carry at their upper end a shaft *G* upon which are mounted two small sheaves *G'*. These sheaves rest against the lifting ropes, and when the latter are tight the shaft *G*, together with the side levers *F F*, are held up and the lever *S''* pushes upward the inner end of the lever *E* so that the clutch collar *E'* is kept out of engagement with the other half of the clutch that is fastened to the stop-motion frame. If the lifting ropes slack up, the shaft *G* will swing outward carrying the levers *F F* with it and thereby rotating the shaft *S'* so as to swing the lever *S''* downward. In this way the inner end of the lever *E* is left free, and a weight resting upon it pulls the end down; thus the clutch collar *E'* is thrown into engagement and the stop motion is rotated, with the results that the brake is applied and the current cut off from the motor, stopping the elevator before the ropes slack up enough to do any damage. The whole construction of the slack-cable apparatus and its mode of operation can be fully seen in the drawings in Fig. 106. In these drawings the bed plate of the machine is omitted in order to show the slack-cable mechanism more clearly. The upper drawing is a side elevation looking in the direction of arrow *A A*, in the lower drawing, which is a view of the under side of the machine with the bed left off, looking in the direction of the arrow *B B* in the upper drawing.

The bent lever *E* is held in the posi-

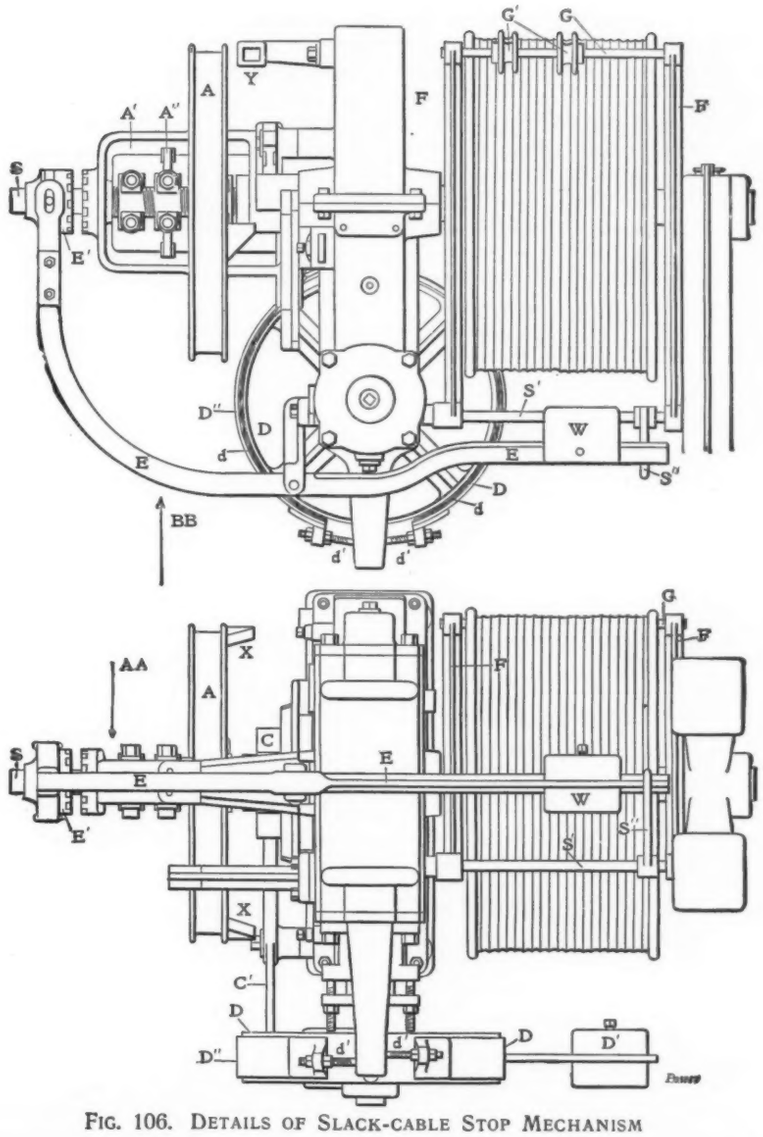


FIG. 106. DETAILS OF SLACK-CABLE STOP MECHANISM

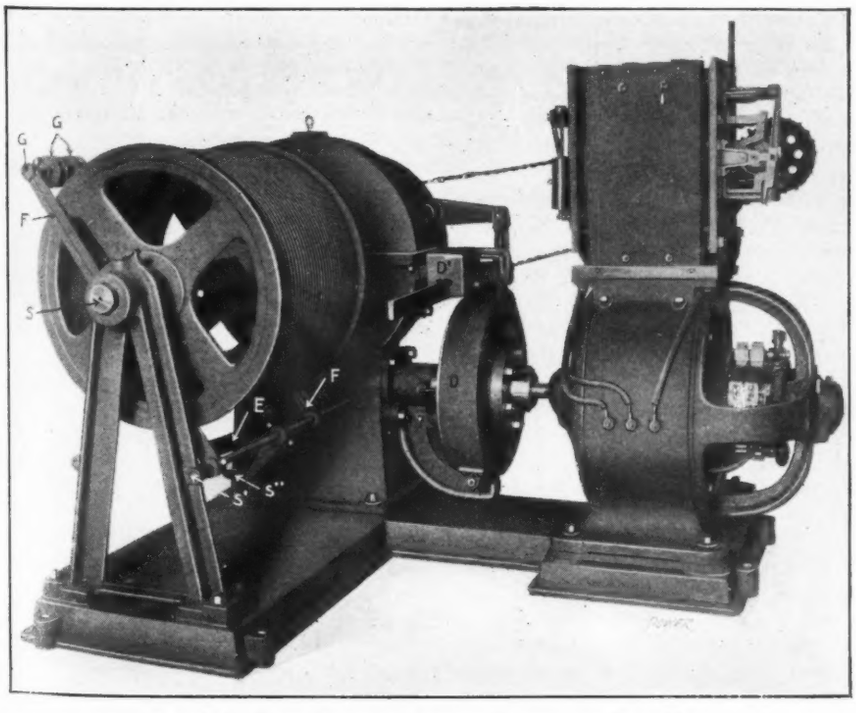


FIG. 105. REAR VIEW OF OUTFIT SHOWN IN FIG. 103

tion shown by the lever S'' mounted on the shaft S'. When the latter is rotated so as to depress the lever S'' the weight W on the lever E causes the right-hand end to move downward and move the clutch collar E' to the right into engagement with the other half of the clutch mounted on the end of the stop-motion frame; then the latter is rotated and the elevator is stopped. In these drawings the brake is shown at D, and the brake straps at D''. The straps have leather facings d, and at their ends have adjusting bolts d', by means of which the distance through which the brake-operating lever has to move to apply or release the brake is varied as may be desired. The operating sheave wheel A is provided with projecing lugs $X\,X$, which serve to prevent too great a movement of the sheave. When the movement is sufficient to set the elevator in motion one of these lugs brings up against a stationary stop Y, which is provided with rubber buffers so as to stop the movement without a jar. All the parts in these two drawings are lettered the same as in Figs. 103 and 105, for convenient reference from one illustration to the other.

The brake shown in Fig. 103 is mechanically operated, but these machines are also made with a magnet-operated brake. One of this type is shown in Fig. 107. In addition to the magnetic brake, this machine is provided with a different design of controller, and the connection between the reversing switch and the operating sheave is considerably modified. Instead of the sprocket wheels

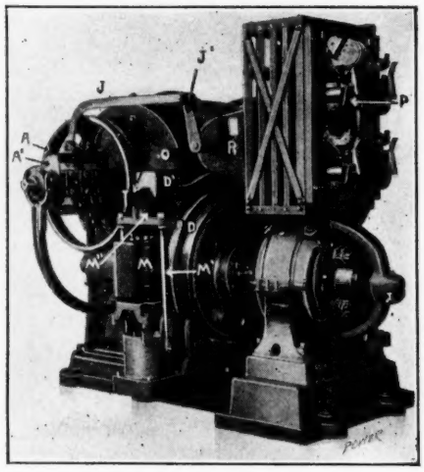


FIG. 107. OUTFIT WITH MAGNET-OPERATED BRAKE

and chain of Fig. 103, a connecting rod J is attached at one end directly to the stop-motion frame A' and at the other end to the crank J' on the shaft of the reversing switch drum. As the brake is actuated by a solenoid magnet (shown at M), the cam C and lever C' are not required. The solenoid M acts to release the brake by lifting the lever C'' through the side rods M' and the crosshead M''. The solenoid plunger projects downward from the lower end and is attached to a cross bar to which the side rods M' are also connected, so that when the plunger is drawn up the rods lift the crosshead M'' and the brake lever C'', and the brake is released. When the current is cut off from the solenoid M, the weight D' on the lever C'' depresses the latter and applies the brake. By varying the position of D' on the lever C'' the pressure of the brake, and consequently the retarding resistance it develops, is adjusted to suit operating conditions.

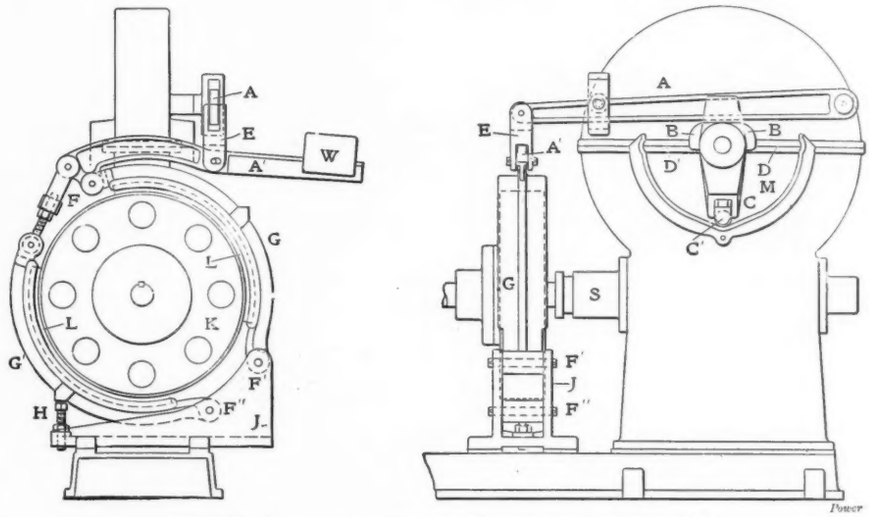


FIG. 108. DETAILS OF BRAKE MECHANISM IN FIG. 107

This brake is different in construction from that shown in Figs. 103 and 105. The latter is of the strap type and the former is of the shoe type. This form is also used for a mechanically operated brake. Its construction is clearly shown in the line drawings of Fig. 108, which presents an end view, parallel with the motor shaft, and a side view, at right angles to the shaft. The former shows all the parts except the magnet (for a brake magnetically operated). The magnet is placed directly under the weight W, as can be readily understood from looking at Fig. 107, and is mounted upon an extension of the base frame J. The two brake shoes $G\,G'$ are pivoted to the frame J at F' and F'', and their other ends are connected with the lever A' through the connecting rods at F, the rod connecting with the shoe G' being provided with means for adjustment. The shoe G' has a seat that rests upon an adjusting screw H, this being provided so that when the brake is off both shoes will stand clear of the wheel.

When the brake is operated mechanically, the levers A and E are added, and a cam $B\,B$ is mounted upon the drum shaft between the worm-gear casing and the stop motion. This cam is made fast to the stop motion. The extension C, on the under side of the stop-motion frame, carries a roller C', the object of which is to hold the apparatus firmly in either of the running positions or in the "stop" position. This roller is pressed outward by a spring with sufficient force to prevent dislodgement when it drops into either of the depressions $D\,D'$, or the one at the bottom of the casting M. It can be moved out of these depressions by the operator when he pulls on the hand rope, or rotates the handwheel in the elevator car, but it requires a strong enough pull to be felt; therefore, when the operator returns the wheel or rope to the "stop" position, he feels when the roller drops into the lower depression and knows that the true "stop" position has been reached. When the elevator is running there is no danger of the reversing switch being jarred out of proper position because either of the depressions at D and D' will hold the stop motion in position against such jarring.

CORRESPONDENCE

What Causes the Excessive Sparking?

What would cause a direct-current generator to burn up the faces of the brushes? The machine is of the interpole type, running at 514 revolutions per minute and carrying 2500 amperes at 244 volts. On a six-hour run, it will burn about 28 brushes so that they have to be sandpapered. Will some reader of POWER give me some information on the subject?

STEPHEN G. LINDSEY.

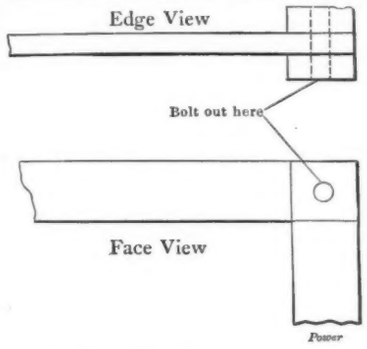
San Francisco, Cal.

[If the machine is not heavily overloaded, the total brush-face contact area may be too small or else the field winding on the auxiliary poles may be connected up backward, so that it opposes instead of assisting commutation. The total contact area of all the brush faces should be not less than 125 square

inches, and 150 would be much better. The polarity of each "interpole" should be the same as that of the main pole next in the direction of rotation. Somebody else make a guess; that is all that can be done from the meager information given.—EDITOR.]

Why Did the Cause Produce That Effect?

We have a little 35-kilowatt 110-volt Westinghouse compound-wound generator which recently gave us a little trouble and considerable anxiety, until the trouble was located. It is our custom at noontime to start up at 12:15 with a load of about 50 amperes which remains practically constant until 12:40, when the full load of about 200 amperes come on. One day recently, when the full load went on the voltage dropped out of sight and



THE FAULTY CONNECTION

the room was filled with smoke. Investigation showed that the tape with which the thin german-silver shunt strip across the series-field terminals was wound had been burned to a cinder, but a close examination of all the connections on the generator and about the switchboard showed everything else apparently all right, so, after retaping the shunt, I started up and kept a close lookout for trouble, but none appeared.

Everything went lovely that afternoon and the next morning, but at noon the same caper was cut up; the generator ran well with the light load but refused to hold the voltage when the heavier load came on. Then began a hunt for loose connections, open circuits or other abnormal conditions, but none could be found.

In our office is a double-throw switch arranged so that we can supply the office circuit from the city circuit when our own plant is not running. A local electrician suggested putting a jumper across this switch to bring the central-station current into our shop circuits, and using it to test out the generator field circuits. We did so, and on testing through the entire shunt field winding the test lamp burned very dimly; then shifting one test terminal back one pole, so that all the coils except one were in circuit, the test lamp burned brightly. This narrowed the search down to this one shunt field coil, and on cutting the tape from the last connection (a copper bar about 1x¼ inch) we found an empty bolt hole, as shown in the sketch.

Evidently, in assembling the machine the joint had been temporarily taped for some reason and later the fact that the bolt was missing had been forgotten. The machine had run nearly two years before corrosion at the unbolted joint had interfered with its operation. After carefully cleaning the joint and supplying the missing bolt, everything went off as smoothly as could be.

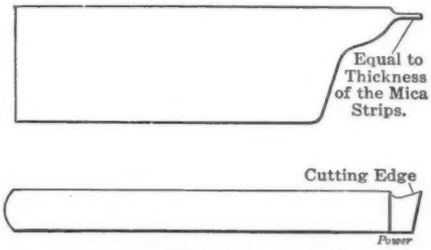
E. H. ROBERTS.

Norwalk, Conn.

[We shall be glad to publish suggestions as to why the loose connection in the shunt circuit caused the generator to burn the tape off the shunt strip of the series field winding.—EDITOR.]

Undercutting Commutator Mica

Some time ago one of your subscribers told how he had remedied his motor "troubles" by cutting out part of the insulation from between the segments of the commutator, and, having "troubles"



TOOL FOR UNDERCUTTING MICA

of my own, I decided to try his remedy.

He said he had used an old hack-saw blade to cut out the insulation and, if I remember correctly, he did the work without removing the armature. The location of my motor did not permit of easy access, so I removed the armature, put it in a lathe and dressed off the commutator. Then I made a tool of the shape indicated by the accompanying sketch and set it in the tool post with the cutting edge in the same horizontal plane as the lathe centers. The play of the dog in the faceplate slot was taken up by means of a wooden wedge, the back gear thrown in, and I was ready to begin operations.

A man was stationed at the belt to bring the mica strips in line with the tool, while I ran the carriage back and forth. By means of chalk marks on the cone pulley and lathe frame my helper soon had an index to show him how far to rotate the armature in order to bring the next insulating strip in line with the tool, and by means of the index on the cross feed I was able to make all the cuts of the same depth (0.015 inch).

After a little practice we made rapid progress and I feel sure that anybody could take down a motor, remove the armature, and cut down the mica in this manner in a much shorter time than they could if they tried to do it by hand without removing the armature.

The remedy worked so well that I immediately treated two other commutators in the same way, and obtained the same beneficial results.

T. F. STEENROD.

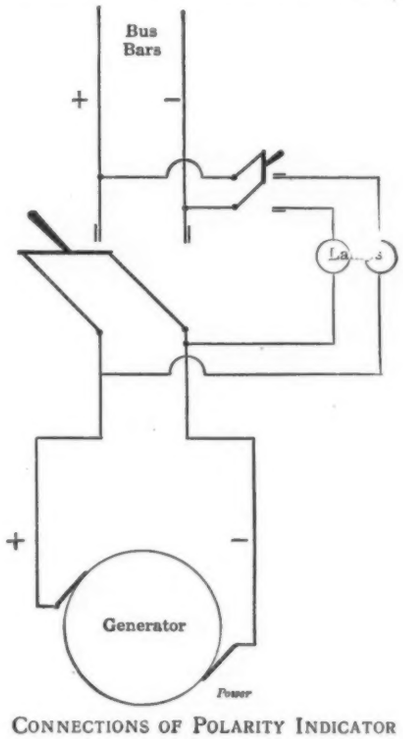
San Diego, Cal.

Polarity Indicator for Paralleling Generators

The accompanying sketch is a diagram of connections for making a simple test to find out whether the polarity of a direct-current generator agrees with that of the busbars before putting a machine into service. Two incandescent lamps of about half the voltage of the dynamo are connected across the main leads of the generator and, through a double-pole single-throw knife switch, to the busbars.

When the dynamo has been brought up to speed and voltage, the small switch is closed, the main switch being left open. If the polarity is right the lights will be dark; should the polarity be opposed, the lamps will burn at full voltage.

When the machine is at a standstill, closing the lamp switch will give the lamps about half voltage. This is no indication of polarity, and should not



CONNECTIONS OF POLARITY INDICATOR

lead the operator to think something is wrong. The machine must be at full voltage and speed to obtain the proper test.

WELDY S. YEAGER.

Colgate, Cal.

Gas Power Department

The Progress of the Diesel Engine*

By E. D. Meier

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

In 1897, R. H. Thurston, after much careful experimenting with steam pressures up to 500 pounds and incisive mathematical analysis of his results, concluded that in actual daily practice the best efficiency we can hope for from steam at 200 pounds pressure is 12 per cent.; at 500 pounds pressure 14.2 per cent., and at 1000 pounds pressure 15.6 per cent. of the energy stored in the coal. By a curious coincidence it was in this same year that Diesel proved with his first 20-horsepower engine that 28 per cent. of the heat value of the kerosene he burned could be realized in actual power in the engine shaft. Early the following year, at the suggestion and risk of an American manufacturer, Diesel showed that his engine could accomplish the same results with the cheap American gas oil or fuel oil of commerce. High economy thus secured, Diesel gave his attention to regulation, and a few years later developed for this purpose an extremely simple principle on which all later improvements in governing engines of the Diesel type are based.

It took fifty years of groping before Corliss, by a brilliant stroke, found the method and valve gear for a practical, variable cutoff controlled by the governor. And yet inventors during those years were dealing with large volumes of perfectly elastic steam. In his engine, Diesel had to slice off a small disk from a mere thimbleful of a heavy incompressible liquid. Five years after his first engine was built he found the principle, and in a few years more his faithful assistants developed the mechanical means of perfect regulation. The American builders of Diesel engines confidently guarantee the speed regulation within 2 per cent., above or below the mean rated speed. For some years now Diesel engines have operated electric-power plants in parallel not only with each other, but with waterwheels and steam engines. In such cases the regulation is invariably left to the Diesel engine on account of its quick and accurate adjustment to changes of load. The economy, great as it was from the start, has been further improved, partly by increase in the thermal efficiency, partly by refinements in mechanical construction.

Operating Economy

While in 1899 we could compare the Louisville Leavitt engine of 13.83 per cent. efficiency, and Rankine's ideal (theoretical) steam engine of 26.2 per cent. with a practical Diesel engine of 28 per cent., the modern and somewhat larger American Diesel engines exceed 30 per cent. efficiency.

The conservative guarantee adopted some years ago, that the consumption of fuel oil per 100 horsepower-hours of net work shall not exceed eight gallons, that is, 0.568 pound per horsepower-hour, has been easily maintained and is now extended to cover running at any capacity between half and full loads. In

*Abstract of a paper read before the National Association of Cotton Manufacturers, April 28.

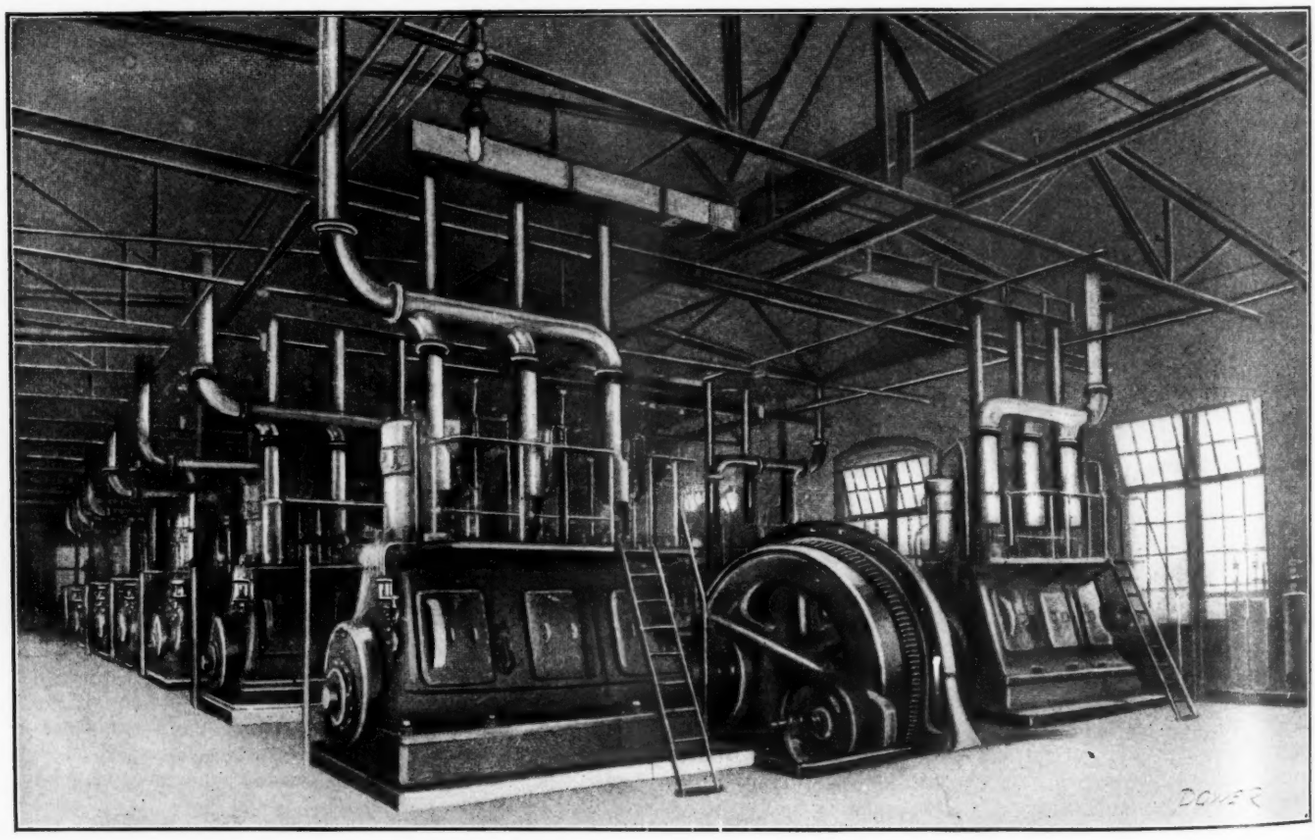


Fig. 1. Diesel Engine Plant at Prairie Pebble

actual duty trials on the testing beds much better results are obtained. The chart here shown gives the efficiency curve from 24-hour tests of six different engines of the 225-horsepower size. At full load the average consumption was only 5.78 gallons (highest 5.94, lowest 5.59) per 100 horsepower-hours, at three-quarter load 5.83, at two-thirds load 5.91, at half load 6.03, at one-third load, 7.27 and at 10 per cent. overload 5.93 gallons.

You will naturally want to know what ratio these figures bear to those with which you now reckon your power cost. Let us, for the sake of argument, allow that these figures will be exceeded in everyday practice, and instead of 5.78 gallons take 6¼ as the consumption per 100 brake horsepower-hours, and an average price of 3 cents per gallon for the fuel oil. Then to get from a noncondensing steam engine the same fuel economy as that of the Diesel engine, you must buy coal for 39 cents a ton delivered on the grates in the boiler furnace; while if you have a good condensing engine you may pay as high as 62 cents a ton. If you live in a favored region where criminal waste has not yet exhausted the natural gas, in order to reach Diesel fuel cost you must be able to buy natural gas for 19 cents per 1000 feet at the gas valve of the gas engine; ordinary illuminating gas you must buy at 12 cents. If you use producer gas you must not pay more than $2.10 for hard coal or 72 cents for soft coal, in your producer, including labor, and you cannot afford to pay more than $9.75 per horsepower-year for water power, nor more than one-half cent per kilowatt-hour for electric current.

The repair account of the Diesel engine is moderate. The average for twenty-one engines of the 225-horsepower size, as reported by the owners, amounts to a trifle over 13 cents per horsepower per annum, the records covering about four years' service.

Marine Applications

Marine Diesel engines have been successfully developed in Russia mainly for oil-tank vessels, in France for submarine boats, in Switzerland for passenger boats, yachts and naval tenders, and in Sweden for auxiliary power for schooners and freight barges. The polar exploration ship "Fram" is now being equipped with a 180-horsepower Diesel engine. Last summer the French submarine fleet, all having Diesel engines varying in total power from 400 to 900 horsepower, made a run from Brest via Cherbourg to Dunkirk and back, a distance of 750 nautical miles, and delivered its successful attack on the battleships in Brest harbor at the end of the run. French naval designers are now planning submarines, each equipped with 1400-horsepower in Diesel engines. While heretofore these vessels were relied on merely for harbor defense, the Diesel engine makes them formidable agencies for attack on the high seas.

In Switzerland, on Lake Zurich, a small passenger steamer was last summer converted into a Diesel boat under the following conditions. The vessel steamed at best speed 8¾ miles per hour, while 11¼ miles was demanded, and the Diesel equipment was not to require more space or weight than the steam plant. This was accomplished with a saving of 35 per cent. in weight, a tenfold increase in fuel-carrying capacity, and a reduction of fuel cost to one-quarter that of the steam engine. Test runs over a 15-mile course showed a speed of 12½ miles per hour, fuel cost 3 cents per mile, or 2.8 miles per net horsepower. The fuel used was Galician crude oil, at $11.50 per ton, equivalent to 3.64 cents per gallon; the results figure to 0.541

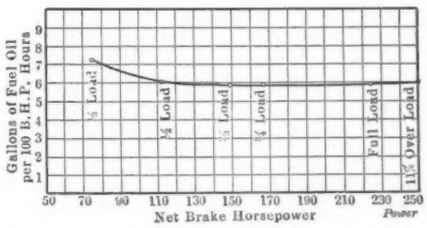


Fig. 2. Average Fuel Economy of 225-Horsepower Engine

pound (0.61 pint) per hour per brake horsepower, or 27.8 cents per 100 brake horsepower-hours.

The Two-stroke Type

It is thus shown that by adopting the two-stroke cycle and giving up a fraction of the marvelous economy of the original Diesel engine, a much lighter engine can be constructed. On this basis a 1200-horsepower express locomotive is being built for the Prussian state railways, which is expected to be ready for tests late the coming summer. In the marine engine and the locomotive the paramount consideration naturally was reduction of weight to a minimum, and for this reason the two-stroke cycle was chosen, with full recognition of the fact that no two-stroke engine has ever reached the economic performance of a four-stroke engine of the same type.

The fuel consumption of the Sulzer marine engine, 7.62 gallons of fuel oil per 100 brake horsepower-hours, though much higher than the American tests quoted, is still within the very conserative guarantee originally adopted. Further improvement of this type is to be expected from the collaboration of the Sulzers, Doctor Diesel and the Borsig Locomotive Works on the express locomotive.

When these experiences are later applied to stationary engines, an intelligent comparison covering all local conditions will dictate the choice between the standard four-stroke-cycle engine of maximum economy and the lighter two-stroke-cycle type, more suitable for large units but with somewhat increased fuel consumption, just as it now does between the triple-expansion steam engine and the steam turbine.

Discussion

In the discussion which followed the presentation of the paper, General Meier stated that the cost of a Diesel engine is about the same as that of a high-class steam equipment with all the modern improvements, including superheater, economizer, etc. The comparison made in the paper with a plain condensing engine did not apply to anything under 120 horsepower. The engine was run from 10 to 15 years with a minimum of repairs. They had an engine which, after a four years' run, had not worn out the tool marks in the cylinder. The largest Diesel engine yet built was a 750-horsepower three-cylinder machine. There was no loss in the excessive compression except the extra friction in the bearings; the energy put into the air by compression was given back again on the expansion stroke.

Two of the members testified to their successful use of the engine. One of them had used two 125-horsepower engines and had put in two others with a considerable reduction in his power cost, because the same man who ran the two engines could take of four, and an increase in wages sufficient to make him happy made little increase in the total wage cost in the plant and a considerable decrease in the wage cost of the horsepower. A large item of the fuel cost in New England, he said, is freight. A carload of oil has as much heat value as three carloads of coal, so the freight on the oil is much cheaper. Oil may be unloaded by simply attaching a hose to the car and letting it run into the tank while coal has to be handled by a mechanical conveyer or shovels. He had given up trying to weigh coal because the coal companies would not accept any weights after the coal had left the car. Oil at 3 cents per gallon equals coal at $3.50 a ton in the boiler furnace. While you would get an evaporation of 13 or 13½ pounds of water from and at 212 degrees per pound of oil against 10½ pounds from a pound of New River coal, you can get much better economy by burning the oil in the Diesel engine.

General Meier said that he had been handicapped in New York by the fact that the Underwriters required that the tank for the oil should be underground and 100 feet away from any building, which had prevented installing any en-

gines in New York City, where it was impossible to comply with these conditions. The only oil that cannot be used in the Diesel engine, he said, is that containing sulphur, which attacks the metal. Water-gas tar, formerly a practically waste product, has been used to good advantage in the Diesel engine by the United Gas Improvement Company, Philadelphia. The power value when used in the engine was about nine as compared to one when burned under boilers. The water used for cooling with the Diesel engine is less than that with the ordinary gas engine. He had taken 3 cents per gallon as the price of oil in this paper as an average price; it could be had today in St. Louis for 2¾ cents.

The gentleman who had been using Diesel engines so successfully said that the first year his oil cost him 3.61 cents per gallon, the second year 4.1, the third year 3 cents, and this year 2.85 cents, delivered at the station. There has been no difference in the quality of the oil, and better fuel economy in the engine.

LETTERS

Cost of Gas Power

On page 858 of the May 10 issue there appeared an article headed "Some Surprising Figures," presenting comparative costs of installing and operating steam- and gas-driven power plants for a hotel building in Boston.

Due to the class of service, a noncondensing steam plant would undoubtedly be required to supply the heating load. If, however, it is desired to separate the heating and power costs and figure on a gas plant for the latter, why not make some assumptions that appear a little bit more reasonable?

Evidently, the gas engine contemplated was to operate on illuminating gas, since it is not customary to compute fuel consumption of suction-producer plants in cubic feet of gas per kilowatt-hour. Is illuminating gas worth 60 cents a thousand cubic feet? I should say not, in Boston, at least, if 35 cubic feet are used per kilowatt-hour. Why, in this section of the country, a little 10-horsepower Otto engine was found upon test to produce a brake horsepower-hour on a gas consumption of 21 cubic feet; and Carpenter and Diederich's "Internal Combustion Engines" gives 18 cubic feet as a fair figure. It seems that 27 cubic feet per kilowatt-hour would be a large figure. It also appears to me that some of the costs given favor the steam engine unduly. The following tables give the results of my deliberations:

ESTIMATED FIRST COST.

Item.	Steam.	Illuminating Gas.	Producer Gas.
1. Boilers (three 100-H.P.)	$3,555		
2. Suction producers			$4,800
3. Engines	5,250	$12,490	12,490
4. Generators	3,890	3,890	3,890
5. Foundations	525	685	685
6. Piping and auxiliaries	2,500	1,022.50	1,165
7. Switchboard and wiring	1,390	1,390	1,390
8. Incidentals, 5%	890	1.022.50	1,162
Total first cost	$18,000	$20,500	$25,580

ESTIMATED OPERATING EXPENSES.

Item.	Steam.	Illuminating Gas.	Producer Gas.
9. Coal	$1,614		$859
10. Gas (using 27 cu. ft. per kw.-hr.)		$3,480	
11. Fixed charges (13% on investment)	2,340	2,665	3,325
12. Attendance	1,320	720	720
13. Oil, waste and supplies	450	500	500
Total operating cost	$5,724	$7,365	$5,404

Sources of information used:

Item

1. Report of Wisconsin railroad commission, March, 1909.

2. Cleghorn's articles in POWER for March, 1908.

3. Steam, Dean Benjamin's formula:

$$\text{Cost} = 150 + (12.8 \times \text{Horsepower})$$

Gas-engine costs taken from Cleghorn's article.

4. A much used formula:

$$\text{Cost} = 12.2 \text{ kilowatts} + \$280.$$

5. Same as in Mr. Dean's assumptions.

6. Steam, same as Mr. Dean's; gas, Carpenter and Diederichs say that piping and auxiliaries should not cost more than 5 per cent. of total cost of plant.

7 and 8. Same as Mr. Dean's.

9. From Mr. Dean's calculations the yearly output is to be 198,000 kilowatt-hours. Two pounds per kilowatt-hour is a liberal figure for coal consumption of a producer-gas plant.

10. Using 27 cubic feet per kilowatt-hour, the cost would be 27/35 of the amount calculated by Mr. Dean.

11. Same as Mr. Dean's.

12. A steam plant of 250 kilowatts capacity would certainly require two firemen, at, say, $600 per year; charge one to heating.

13. Same as Mr. Dean's.

From the above, it is evident that the producer plant would be the cheapest in the end, with the steam plant a close second. The illuminating-gas plant would not be considered.

In spite of all the calculations that could be devised that would favor the gas-engine plants in every possible way, the steam plant is much better suited to the requirements of this service. A proper basis for calculation would be that of power and heating combined, with the necessary installation of heating boilers for the gas-power plant.

J. C. PARMELY.

Urbana, Ill.

Mr. Dean's figures on the relative costs of gas and steam plants and their operation, as published in the May 10 issue, are indeed "surprising," not to say absurd. If his cost figures are correct, then the manufacturers of gas engines must be amassing wealth by the carload. If his attendance figures are accurate, either the steam plants known in Boston must be remarkably automatic or the gas engines with which he is familiar belong in the engineering nursery.

It is usually true that a good steam plant is cheaper to operate than an engine using illuminating gas, unless the running periods are very intermittent, and Mr. Dean could have demonstrated this more forcibly with correct figures than with his exaggerated "estimates." The worst discrepancies in his figures are as follows:

	Steam.	Gas.
First cost of engines and generators, including boilers	$8,408	$20,950
First cost of piping and auxiliaries	2,500	3,000
Annual expense for attendance	720	720

Assuming that the generators would cost $3900, which is a fair estimate, the cost of the boilers and engines would be $4500 as compared with $17,000 for the gas engines; anyone familiar with the subject knows this comparison to be absurd. Diesel engines, which are the highest-priced prime movers built, would cost about what was "estimated" for the gas engines.

The next item is equally absurd as to proportions. "Piping and auxiliaries" naturally include pumps and feed-water heaters for the steam plant, whereas the "auxiliaries" for an illuminating-gas engine are a small pump for the circulating water, usually attached to the engine and included in its price, a water tank, and a muffler. The whole outfit, including the piping, would be dear at $1200.

The third item in my list of "notables" is a fitting companion to the first two. One man could easily attend to the gas engines, but the steam plant would certainly require two.

There is still another aspect of the case. A producer plant to use pea coal would cost about $25,000 complete, *with auxiliaries for utilizing the waste heat of the engines,* and the operating costs would foot up considerably less than those of the steam plant, even allowing for the larger interest and depreciation charges.

It seems rather obvious that Mr Dean's figures are not exactly impartial.

GEORGE W. MALCOLM.

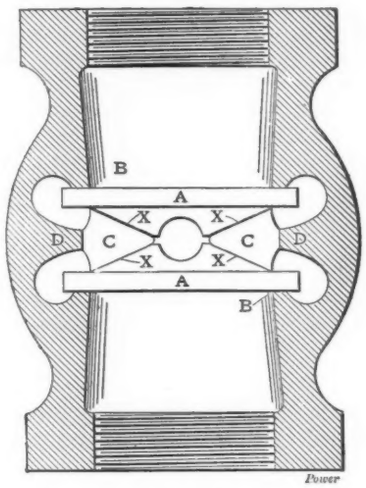
Brooklyn, N. Y.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Making a Gate Valve Tight

Recently, in some pipe work here, we had a sudden call for a 3-inch gate valve, and the only one on hand leaked badly. There was not another to be had nearer than Birmingham and we wanted one for immediate use. We took apart the one we had and everything seemed O. K., assembled it again and found that it leaked as badly as ever. A few minutes' experimenting developed the fact that when screwed down apparently tight, the gates *A* in the figure were not tight against the seats *B*.



SECTIONAL VIEW OF VALVE

We took the valve apart again, and found that the wedges *C*, which were expected to spread the gates *A*, were crowded toward the center by the stationary projections *D*, and did not bear tightly against the gates. We took out the wedges and, after carefully tinning them, soldered a piece of No. 20 gage brass along each surface marked *X*. After assembling, before which the solder and rough edges were filed off, the valve held 100 pounds steam pressure with no leakage.

A. H. BULLARD.

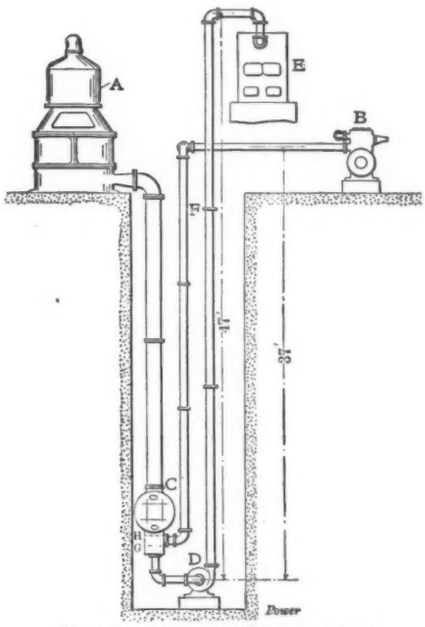
Talladega, Ala.

Vacuum Trouble

The accompanying illustration shows a steam-turbine installation with some of the auxiliaries. The turbine is represented by *A*; *B* is the dry-vacuum pump; *C* the surface condenser; *D* the centrifugal hotwell pump, and *E* the open feed-water heater.

When making the initial run on this turbine, we had what appeared to be a very peculiar vacuum trouble. The vacuum at starting ran to 29 inches. After running only a few minutes, the vacuum gradually dropped to 18 inches and the air pump apparently ceased to exhaust any air. When reaching this low point, the vacuum rose rapidly again to 29 inches. This cycle of variation constantly repeated itself.

Endeavoring to locate the trouble, we first inspected the valves on the air end of the vacuum pump, but these were found to be in perfect condition. The circulating pump was doing its work, as could be told by applying the hand to the shell of condenser, which always remained cool. It did not seem reasonable that a simple air leak into the turbine, condenser or connecting pipe would cause this intermittent rise and fall of vacuum.



ARRANGEMENT OF TURBINE AND AUXILIARIES

We next dissembled the hotwell pump. The shaft was found slightly sprung and was accordingly straightened. Otherwise the pump appeared in good condition. We finally decided that for some reason the hotwell pump was not removing the water as it should; water of condensation apparently accumulated in the hotwell until the outlet to the vacuum pump was sealed thus rendering the vacuum pump no longer effective in removing the air.

In order to obtain positive proof that our diagonsis was correct, we installed a gage glass on the hotwell. At starting the turbine, the vacuum gage registered 29 inches as usual. When the water reached the hight *G*, the vacuum began to fall and by the time the water rose to *H* the vacuum was down to 18 inches. The hotwell pump then began to remove the water at a high rate and the vacuum reached 29 inches by the time the water level was brought down to *G*. As before stated, this cycle of operation was constantly repeated.

It was now clearly proved that the hotwell pump was not doing its work properly. Upon examining the suction pipe to the hotwell pump, we found that the pipefitter had bushed the pipe from 3 to 2½ inches. There were also two or three unnecessary bends in this pipe which had a tendency to retard the flow of water. This suction pipe was enlarged to 3 inches and run direct to the pump as shown in the sketch. The turbine was started again but the same trouble was in evidence.

We next disconnected the discharge pipe from the hotwell pump at point *F*. The pump handled the water to this hight without difficulty and the vacuum was maintained at 29 inches. We finally came to the conclusion that the hotwell pump was of insufficient capacity to handle the water under the head required of it, and were on the point of wiring for one of the pump manufacturer's experts to come and help us out of the difficulty when one of our men happened to tighten up on the shaft stuffing-box gland of the hotwell pump. The pump immediately took hold of the water and did not allow it to rise again above the level *G* in the hotwell. Thus the trouble caused from air leaking into the pump was at last located and remedied.

G. J. REYNOLDS.

Anniston, Ala.

Blowoff Connections

I have noted with interest the articles in POWER dealing with defective blowoff pipes, and I wish to relate two incidents in that respect which recently came under my observation.

The first was at a plant in Indiana, where a battery of five boilers was operated at a pressure of 90 pounds. The blowoff pipe was fitted up as shown in Fig. 1, and when examined it was found that a piece had been burned out of the

lower end of the tee, and the plug was missing. A closer inspection revealed the fact that during the time the plug had been in the tee, a layer of sediment about ½ inch thick had formed on top of the plug; and when the latter fell out, this layer held the 90-pound pressure without showing signs of a leak. The indications were that the pipe had been in this condition at least several weeks.

The lesson to be drawn from the above is that no tee should ever be used in

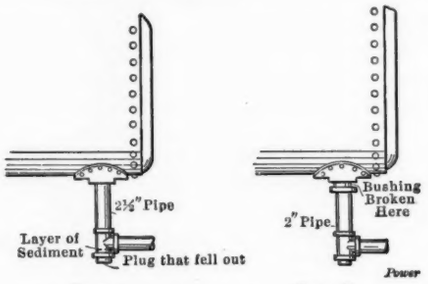


FIG. 1 FIG. 2

FITTINGS, SHOWING POINTS OF FAILURE

connecting a blowoff, and that the pipe should always be protected from the heat.

The other incident was observed at a plant in Kentucky, the blowoff pipe being connected as shown in Fig. 2. The arrangement broke as indicated after it had been in use about three months, with a pressure of 90 pounds on the boiler. Fortunately no one was injured.

It is obvious that this manner of connecting the pipe was a poor one. If a bushing is used it should be screwed into the flange as far as the shoulder and the inserted pipe should have a long thread which can be screwed in nearly flush with the inside of the shell.

T. J. HANNA.

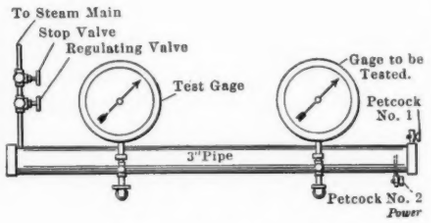
Cincinnati, Ohio.

Gage Testing Device

The testing and setting of pressure gages in small and isolated plants under ordinary conditions has to be left to the boiler inspector, or they are not tested at all. The following sketch shows an arrangement made of ordinary fittings which can be picked up around any plant and if carefully handled will secure very accurate results.

Take a piece of standard 3-inch pipe 24 inches long and cap both ends. About 8 inches from each end drill and tap for ½-inch pipe, and with two ells on each, turn up and fit with standard-gage fittings. On the top, tap for a ¼-inch steam-main connection and fit two valves; one a stop valve and the other to be used as a regulating valve. On the opposite end of the 3-inch pipe, fit two ¼-inch petcocks as shown, the nipple on the lower one extending up about 2 inches inside of the pipe.

To operate this arrangement, let the 3-inch pipe fill with condensed water until it runs out of petcock No. 2. This gives a supply of clean water and eliminates all chance for hot steam to injure the gages. Shut petcock No. 2 and open the gage cocks; this will give full boiler



GAGE TESTING DEVICE

pressure on the gages. Fluctuations in pressure can be controlled by choking down with the regulating valve. If the pipe fills up with water, open No. 2 petcock and drain. Never use No. 2 petcock to regulate the pressure as water flowing through the small orifice in the cock will cause the pressure to fluctuate.

The 3-inch pipe should be set as nearly level as possible.

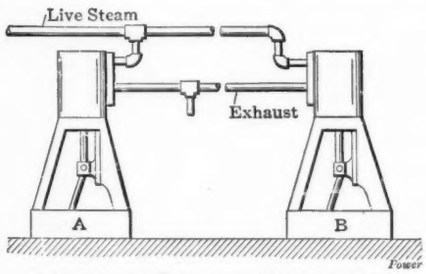
J. E. BENSON.

Des Moines, Ia.

Water in the Cylinder

That an engine cylinder can, and does under certain circumstances act as a pump is in my opinion a certainty. I had an experience about two years ago that convinced me that such could be the case.

We had two vertical engines piped as



SCHEME OF EXHAUST CONNECTIONS

shown in the accompanying sketch. The engine marked *A* was used to drive a small dynamo for lighting and the engine marked *B* furnished power for the machine shop.

One morning one of the machinists started the shop engine and in a few seconds the dynamo engine kicked out its cylinder head and bent the piston rod. The fact that the piston remained whole made it evident that the wreck was not caused by the piston breaking and a piece getting between the piston and head. The dynamo engine was very lightly loaded at the time, it being daytime, and with but very few lights in use.

My theory is that the steam in the cylinder was expanded considerably below atmospheric pressure and when the dynamo engine opened to exhaust, water flowed from the exhaust pipe into the cylinder. The engine trapped this water by closing the exhaust for compression and having a piston valve and no relief valves, was unable to relieve itself. The fact that the engine was governed by a shaft governor which reduced the travel of the valve for light loads made the exhaust close earlier and so helped matters.

The exhaust piping was changed so that each engine had separate exhausts and no more trouble from water was experienced.

There had always been trouble from water when the dynamo was lightly loaded at the time the shop engine was started.

There was no question of the dryness of steam supplied to engines as there were three separators in the steam pipe, each supplied with a trap in good working order. One trap was in the main steam pipe at the boilers, one in the steam pipe at a point where steam was taken for another engine, and one at the engines in question.

ALBERT T. ROWE.

Wethersfield, Conn.

Metal Stacks

The subject of metal stacks still seems to be a very live issue. It has fallen to my lot to be associated with the building of a number of metal stacks of various sizes, and the question as to which way the sheets should be lapped, was discussed just as earnestly when our first stack was built as it is at the present time.

Some were built with the outside lap up, others with the outside lap down, and some with straight sheets; consequently when the first few of these stacks gave out and were taken down we were very much interested to ascertain the condition of the seams and find out which method had withstood the wear best.

We found the inside laps in both types of seam to be in practically the same condition; whether they were placed up or down having made no difference whatsoever.

There being no difference in the wearing quality, the appearance is the only other consideration. A stack built with the outside lap down certainly presents a better appearance than one built with the outside lap up or with straight sheets.

In all cases of stacks that we have taken down, the sheets have been reduced very evenly, except the outside lap at the seams, which has been wasted only where the inside sheet was entirely gone.

Care should be taken to calk all seams so that there can be no leaks, and the

rivet holes should be punched from the outside. This places the larger end of the hole toward the inside, so that when the rivet heads are wasted away, the taper of the rivet will hold what is left of the sheet.

The same thickness of metal should be used for the full hight of the stack, as the upper part always gives out first, the lower part usually being good for several years of service after the upper part is too thin for further use.

There should always be a band around the stack for the guys to be fastened to. Where the fastenings are riveted to the sheet they are very liable to pull off, the constant movement of the stack and guys causing the corrosion to flake off near the fastenings, thus wasting the sheet faster at those points.

It is also good practice to rivet on several lugs, to prevent the guy band from slipping down. These lugs should be located on a seam where there will always be enough metal to hold them.

Every stack should be equipped with a ladder. It does away with the necessity of maintaining blocks and wire ropes for the inspectors' and painters' use. I recall one case in which the small rope corroded at the block and broke, thus making it necessary to employ a steeplejack to climb the stack and replace it at an expense that would have almost paid for a ladder if it had been applied when the stack was built.

The ladder should be located on the northwest side of the stack. In my experience I have found that where there is any perceptible difference in the corrosion, it has been greatest on that side, due to the fact that the cold storms blow against that side, causing greater condensation of the products of combustion.

The kind of fuel burned makes considerable difference in the life of a metal stack. Coal high in sulphur or volatile matter, which produces a large quantity of smoke with soft soot, will attack the metal much faster than coal low in sulphur and volatile matter. The question of good or poor combustion should also be considered, as with good combustion we have very little smoke or soot and consequently less corrosion of the stack.

W. J. PEAD.

North Adams, Mass.

Some Experience with Shaft Governors

While operating two direct-connected alternators in parallel it was noticed that one of the engines had a tendency to take all the load. The chief claimed it was caused by the governor springs being too tight on the machine that was taking the greater load. But investigation showed that one of the gag pots was empty and on filling it with cylinder oil the engine regulated all right.

The pin that holds the eccentric to the flywheel is also likely to give trouble provided it is not properly lubricated, and it is also liable to wear out of round.

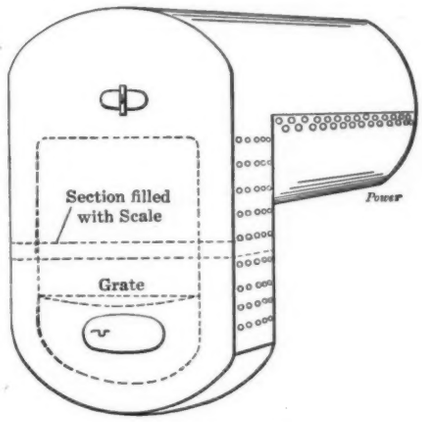
I consider it a good plan to take shaft governors down about once a month and thoroughly wash all the bearings with kerosene oil. Never use anything but the best of grease or oil on the hanger pin. Cheap grease and oil will gum and the speed will be very unsteady.

H. B. ADCOCK.

Newman, Ga.

Scale in the Boiler

During my early engineering experience I had a peculiar case of bad scaling. The boiler was of the round-bottom locomotive type, as shown in the sketch, with water space all around the bottom of the furnace. It was used in a portable sawmill, the fuel consisting of sawdust and slabs. I made a practice of washing it out by means of a hand pump every two weeks and after running about three months, I noticed two rows of staybolts inside the firebox about a foot above the grates, to be leaking badly, and soon after this, noticed that the plate between the rows was bulging slightly. At the end of the week I attempted to blow the boiler down as usual and upon opening the valve, I found no pressure on the water.



LOCATION OF SCALE SHOWN

The boiler was accordingly allowed to cool off and with the aid of a small mirror, a candle and a piece of wire, I located the trouble. Between the two leaky rows of staybolts the space was a solid mass of scale extending all way around the firebox. This accounted for there being no pressure when opening the blowoff valve and also for the sheets being bulged at this place. The scale was finally dislodged by drilling holes at the corners and using an iron rod to break it up.

I remained in charge of this boiler for a long time after this but never had any more trouble. I have never been able to make out just what caused all the scale to accumulate in that one place but am quite sure that had I fired up again after emptying the boiler of the cleaning water, the result would have been disastrous.

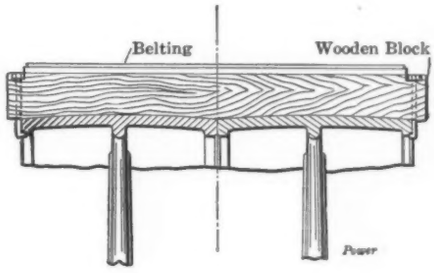
A. J. FERGUSON.

Vernon, B. C.

Lagging a Pulley

It is sometimes necessary to change pulleys for those of a different size, and when the change calls for an increase in size, it may often be done by building up the old pulley to the required diameter with a suitable lagging. The accompanying sketch will help to explain how this object was accomplished on the pulleys of a pair of engines of which I once had charge.

There were two heavy band flywheels, 12 feet in diameter and each carrying a 24-inch belt, the pulleys being located a few inches apart on the shaft. It was decided to place them close together and lag them up to admit using one belt and at the same time increase the diameter by 15 inches. Pieces of pine, 3 inches thick by 6 inches deep, were fitted to the face of the pulleys, each end projecting beyond the rim far enough to contain a bolt with a projection which hooked under the inside edge of the flange, as shown in the illustration. The bolts were forged especially for this purpose and were square in section where they came in contact with the edge of



SECTION SHOWING LAGGING

the pulley, thus preventing any possibility of turning. The outer end of the bolt was threaded to receive the nut which was let in flush with the face of each section, a socket wrench being used to set them up. Outside of the pine sections were others of maple, 1½ inches thick and the same width as the pine, fastened on with wood screws.

After these were in place, the engines were run slowly and the surface and edges of the lagging were trued up. Then a width of a little over 48 inches was covered with 4-inch leather belting, wound tightly and glued as it was put on, and afterward pegged.

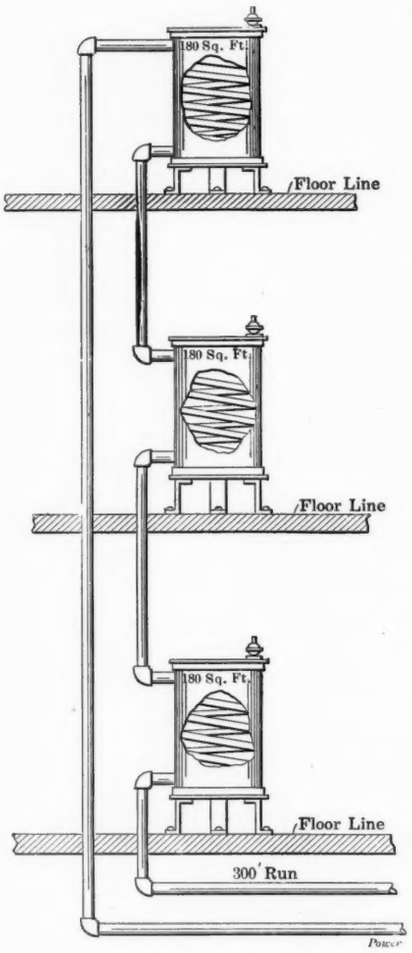
This made an excellent job which was used for a number of years and gave the best of service.

H. M. WINSLOW.

Cumberland, Mills. Me.

An Antiquated Heating System

In the building in which I am employed, part of the hot-water heating system which was installed when the building was erected nearly seventy years ago, is still in operation and giving good results. As will be seen by the accompanying sketch, it is according to the old "Hyde" system. The feed pipe and all



SYSTEM OF CONNECTIONS

other connections are of 1-inch pipe. There is about 690 square feet of radiating surface, counting radiators and mains, on the single 1-inch feed pipe and no difficulty is experienced in keeping the rooms hot. I have reason to believe that this is about the first hot-water heating system installed in America.

JAMES E. NOBLE.

Toronto, Canada.

Cutting Down the Cost of an Elevator Service

An instance recently came within the writer's observation of what an ambitious engineer may do by way of a few judicious changes. The case referred to is that of the elevator plant in a department store.

Twelve elevators were in use, the system being divided into two units with one pump for each unit. One of the pumps having practically worn out, it became necessary to make a change. The worn-out pump was abandoned, the two pressure tanks, each with a capacity of 6200 gallons, were connected together and a third one of about the same size added. To these were connected a 16 and 25 by 15-inch Worthington compound duplex pump. By this arrangement one pump which had hitherto driven only six elevators now operated twelve with a total pressure-tank capacity of 93,000 gallons and at a slightly reduced speed.

Owing to peculiar building conditions the smokestack of this plant had been installed with a siphon bend, necessitating a downward travel of the gases of 16 feet before reaching the stack proper. To overcome this, 25 feet were added to the top of the stack. In addition, considerable scale was removed from the boilers, and a coal-consumption test was made.

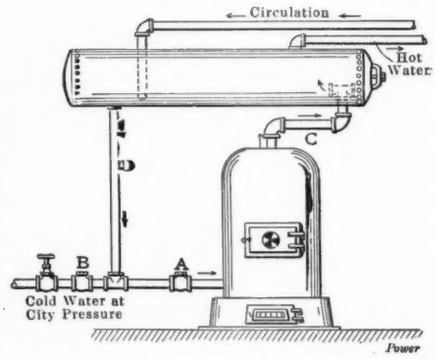
Before making the changes, 18 tons of coal at $4.50 per ton were used each day. After they were made, the daily consumption was only 6½ tons of an inferior grade of coal at $3 per ton, and one boiler was cut out of service for reserve.

EDWARD T. BINNS.

Philadelphia, Penn.

Check Valves

In an apartment house of which I have charge the hot-water tank was repiped and a new heater installed. A few days later the janitor informed me that it was impossible to heat the water in the tank, although he was running a very good fire in the heater. On inspection I found that the pipe *C* was just warm and the pipe *D* stone cold, although there was a good fire in the heater.



LOCATION OF CHECK VALVE

On carefully examining the piping I found that the plumbers had put a check valve at *A* so as to stop the hot water from backing up and spoiling the water meter. I took the check valve out of the circulating pipe and put it on the other side of the tee at *B*, after which the janitor had to keep a low fire, to prevent the water from getting too hot. A check valve is a very good thing between the city pressure and the heater but is useless between the tank and the heater.

JAMES R. WILD.

Cambridge, Mass.

Repairing a Crank Pin

The permanent and satisfactory repair of a large crank shaft is shown in the accompanying sketches. The fracture is

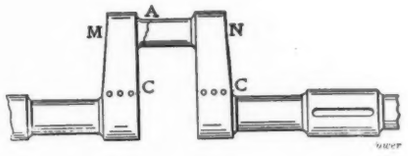


FIG. 1. CRANK SHAFT SHOWING CRACK

shown at *A*, Fig. 1, the repair of which had been attempted by putting a large bolt through the crank pin from the points *M* to *N*. This was not successful, as the great amount of strain soon loosened the bolt.

Permanent repairs were effected by drilling off the two crank arms at the points *C*, Fig. 1; and in this way saving the ends of the shaft with the important fits. When this was done the shaft was turned down as shown at *B*,

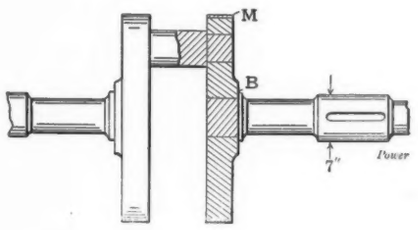


FIG. 2. MANNER OF REPAIRING CRANK

Fig. 2, and two cast-iron disks of heavy proportions shrunk on and a dowel key inserted. Next, wrought-iron reinforcing bands *M*, Fig. 2, were slipped over the rims of the disks and shrunk on. This having been done and the plates faced true on the centers, we were ready to drill the crank-pin holes. In order to do this accurately the plates were placed face to face and clamped firmly together, then placed in a lathe to insure their coming true with the old journals. The crank-pin holes were then bored, two additional holes being drilled on the opposite side for a guide pin to assist in keeping alinement while the crank pin was being forced into place. After placing the crank pin the shafting was assembled and satisfactory results attained.

C. R. MCGAHEY.

Sheffield, Ala.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Safety Appliances

In the April 26 number, H. R. Rockwell says that good safety appliances become worthless through the carelessness of the man in charge of them. I was talking this over with an old engineer last week. He said that if there were less of them used there would be fewer accidents, and I believe him.

In my plant there are safety water columns on three boilers with high- and low-water alarms and self-closing gage valves. It was on account of neglecting to close these at night (because they were supposed to be automatic) that the man before me got into trouble. The glass broke during the night and he was pretty short of water next morning.

I have all the trouble I want with the columns myself since I have had them for I have seen them blow with two gages of water in the boiler and continue until they got good and ready to stop.

This has been my experience with them and I do not lay any claim to being careless either, for one cannot cut a boiler out every day just to find out what kind of a freak has struck the column.

C. E. GRANFIELD.

Boston, Mass.

Receiver Pressure

In a recent issue, Louis F. Cooling states:

"In the same plant are two cross-compound engines, 22 and 48 by 42 inches, driving 750-kilowatt, three-phase generators connected in parallel. If when the load is equally divided between the two machines, the receiver pressure is raised on one and lowered on the other, the load of the former will decrease and that of the latter increase."

Here we have two three-phase generators of equal size electrically bound together just as firmly as if the engine shafts were clamped by an absolutely nonslipping but flexible clutch. If, therefore, at any time the load is equally divided on the machines it must remain equally divided as long as both throttle valves are open and the engine governors are playing anywhere between their high and low stops. Raising the receiver pressure on one may cause that engine to slow up and use more steam, but, invariably, the other engine will also slow up and use more steam. It is almost an impossibility to cause one engine to do more work than another of equal size and in equal condition working under the above conditions. Even if the governor of one is weighted down, the speed of both engines will increase, and the steam valves of each will open and close in exactly the same period of time. It is true the two generators may "buck" one against the other, and that the pointers of the ammeter may show different loads, due probably to a difference of power factor, but the measure of work done is the steam consumed in the cylinders, provided, of course, that the efficiency of both engines and both generators at variable speed and load is the same.

Mr. Cooling can easily verify my statements if his two engines are of the Corliss type and if the generators are direct connected, by just watching the dashpot rods. Should the generators be so synchronized that the dashpot rods of the engines do not drop in step, then no amount of monkeying with the receiver pressure or anything else will cause them to come into step, and naturally if one takes more load than the other it must run slower than the other to obtain the steam necessary to carry that load. Those who doubtlessly will see points in this letter to criticize must bear in mind the conditions given and assumed, which are: Two engines of the same dimensions and efficiency; three-phase generators, direct connected, running in parallel and of equal efficiency; a load that will not bring the governors down on their starting pins; the same initial pressure at the throttle of each engine and a load which was equally divided before changing the receiver pressures.

HUGH HUGHES.

Roxbury, Mass.

Governor Trouble

While reading of J. McMahon's trouble with the governor of a Corliss engine, I was reminded of having the same experience a few years ago with a 14x30-inch Corliss. I learned that the trouble was easily overcome.

There is, or should be, a rest for the governor on the post, and this should be placed under the governor as the engine is stopping or else put under before starting. I found that the former way saved the trouble of raising the governor by hand. This rest holds the governor clear of the safety blocks until speed is attained, then the governors rise and the rest drops out of place of its own accord and is clear to allow the governor to act on the safety block in case of derangement. If Mr. McMahon's engine has not got this governor rest I do not think that it is complete.

ALFRED WEBBER.

Medicine Hat, Alberta, Canada.

Blowing Mud from Boilers

In POWER for April 12, G. E. Miles makes a suggestion for blowing mud from boilers. His idea is to run a perforated pipe along the bottom of the inside of the shell. This is old. I had such an arrangement in my plant until I was ordered by the inspector to remove it. It was claimed that scale would wedge under the pipe and in time cause the boiler to burn or bag. The pipe did not prove to be of much worth; in fact, a top skimmer is of much more value.

MILTON HEGLIN.

Dayton, O.

Theory and Practice

I was much interested in the editorial in POWER for April 26 on "Theory and Practice." The editor certainly hits the nail on the head when he says that a "technical" man must be "practical" to make a real success of engineering. Yet, so many college graduates have an idea that when they leave college the next step should be a desk job and that the overalls and dirty hands are for the man who has not been lucky enough to enjoy the advantages they have had. Dut of what benefit is the theory learned at college if there is not good solid experience to back it up? A man can be a successful engineer who has never had any technical training, but I never yet heard of an engineer who made good without sound practical training to supplement his theory.

The first job I had after leaving college was to make myself generally useful in a substation. Then I proceeded to forget about 75 per cent. of superfluous knowledge I had acquired during the previous four years. I soon learned that theory was all right, in small doses, but what was needed to operate a switchboard or synchronize a rotary, was practice and plenty of it. Most of the theory was left to the men who had served their turn and had moved up several rungs.

A good many men are against college training for engineers, and when asked to give some reason to support their

views, say: "You don't need a college training to be an engineer. Look at———, one of the finest engineers there is, and yet he never saw the inside of a college."

This is quite true, but did these men ever stop to think how much better an engineer this man would have been with a college training? It is not a question of certain practical men being better than certain other technical men, but what would be the relative value of the same man with and without a college training?

JOHN FRENCH.

Washington, D. C.

A Question of Governors

In the April 26 issue, F. L. S. asks advice in regard to securing better speed regulation of his engine which is equipped with the old-fashioned, flyball governor.

I once had charge of an engine which was controlled by a Gardener governor. The engine was originally operated at 160 revolutions per minute. When we cut the speed down to 125 revolutions, the regulation was not good. We overcame the trouble by increasing the speed of the governor. The outfit was 20 years old at the time the change was made. The engine is giving very satisfactory service now.

I. SAWYER.

Hartsdale, N. Y.

Standard Colors for Station Piping

To those mentioned by Mr. Sparrow in POWER for April 26, one more requisite of a color scheme for station piping should be added, the colors must be easy to distinguish. Piping is often laid in poorly lighted passages and it may so happen that at the time when it is most important to be able to recognize the pipes, the whole place may be filled with steam or smoke.

I agree with Mr. Sparrow that tints should be avoided and would, therefore, exclude No. 8, pompeian red, as being nothing but a tint of vermilion used in No. 14. I should, for the same reason, exclude the orange, Nos. 4 and 5, for, with some dust on it and under the light from an incandescent lamp with a carbon filament, it will look too much like vermilion. The same applies still more forcibly to the case of the orange pipe with vermilion bands, No. 5, which would very soon get to look like the vermilion of No. 14.

It is also questionable whether green and red should be used simultaneously. The railroads have used them now for about half a century as the most showy colors, but have had plenty of trouble with them owing to employees being affected by daltonism. The railroads have now introduced very severe eyesight tests which have shown that a surprising number of people cannot tell green from red. Stationary engineers and firemen undergo no such tests, but the percentage of them with affected eyes is just as high, and it would, perhaps, be advisable to avoid the use of the most easily confused colors.

The idea of working out a standard scheme of colors for piping is a very good one, but great care must be taken in carrying it out. Before any standard scheme is introduced, tests should be made under the supervision of competent opticians to show that the colors are not changed by gas and electric light, and that they can easily be distinguished by a man with average eyesight under reasonably unfavorable conditions.

L. GOLDMERSTEIN.

Champaign, Ill.

The suggestion in POWER of April 26 for marking the different pipe lines of power stations by painting them different colors is good although not entirely new. This method has been in use in the navy for a number of years. Over 15 years ago I was assistant engineer on a ship with a chief who had been a first-class machinist in the navy. He adopted a method of marking the pipe lines on board our ship which was quite simple. The one suggested in POWER would be likely to bewilder the men in the engine room more than to assist them in case of emergency, on account of the number of colors. For instance, the steam-drip lines are orange with black fittings, while the gravity drips are orange with red fittings. The men would be more likely to make a mistake if they were rattled if they had to keep all these colors in their heads than if they had been instructed as to the use of the different lines beforehand and fewer colors were used. They would then be more likely to do what they were told to do. I agree that the painting of the *principal* pipes is an excellent idea if not carried too far, in which case it would complicate more than simplify matters.

The scheme used on the ship of which I have spoken worked very satisfactorily. It was as follows: Live-steam lines for whatever purpose were painted buff color, including the drips; all exhaust lines and returns from the heating system, dark red; fresh-water discharge lines, green; fresh-water suction lines, black; the salt-water suction pipes, in this case, were copper, as were the feed pipes; the salt-water discharge for fire pumps was bright red.

I believe in getting the most intelligent help possible, both in the fire room and the engine room, and explaining to the men just what everything is for and seeing that they understand and know what to do in case of emergency.

A. C. EVANS.

Hawthorne, N. J.

The subject of standard color schemes for station-piping systems is one of more than usual interest. By the use of a color system much liability of delay and accident may be eliminated. If some scheme of coloring could be made standard and if it were used universally, matters would be greatly simplified.

I would like to offer this suggestion for making a color scheme more valuable. Have on every floor a pipe diagram or map and color chart. Have the diagram show the size and location of each pipe on that floor, what it carries, the direction of flow, the location of the valves and the color it is painted.

To illustrate how convenient such a combination would be, I will tell of the experience of a hotel man which came to my notice. He had laid up his heating boilers for the summer. There came a cold spell and he wanted to steam up for a short time. In the absence of his fireman, he was at a loss to know how to blow off or fill his boilers. It seems that the boilers were fed through the blowoff. He had to call in a steamfitter to trace the thing out for him. Had he had a chart or map he could have got along without calling in outside help.

I certainly think that a pipe map for each floor, suitably protected by a glass cover and located in a conspicuous place, would be valuable inasmuch as it would greatly simplify matters when tracing out a pipe line even though the pipes were painted in accordance with a given scheme.

C. R. MCGAHEY.

Sheffield, Ala.

The timely article on the above subject, recalls to me its application in the naval service.

Very little extra expense is incurred by following a standard color scheme, as it has been proved that it is economical to paint either covered or uncovered lines.

My experience has been that, for various reasons, very seldom is the complete chart lived up to. Paint on hot, bare brass or copper pipe has a tendency to scale off; besides, brass pipe about an engine adds to its appearance and is not hard to keep bright. About the only color that will stand the temperature of high-pressure or superheated steam, if used on bare pipe, is black or aluminum bronze; white-lead paint turns yellow, green becomes almost black and some of the tints are too delicate and soon become unrecognizable.

When a ship leaves the yards, all piping is painted according to the standard color charts, but after a short time, as a result of repainting by the crew, only about four of the standard colors will survive; namely, white, black, red and green.

In view of the above, I submit the fol-

lowing chart, which contains enough colors so that when used in combinations the more important piping systems found in the average plant may be distinguished:

Superheated-steam lines	White (French zinc), vermilion bands.
All other steam lines,	White, brass bands.
Steam exhaust, drip lines, bleeders	All white.
Salt water suction, or in case of inland plants, city water	Light green.
Brass feed lines, oil piping—as far as exposed	Polished.

French zinc stands heat much better than does white lead; a little green or some varnish can be added if desired. The above colors are permanent, easily mixed and form a pleasing contrast.

In addition to painting the pipes as means of identification, especially in the marine service where some pumps can be used in numerous combinations for suction and discharge and where the piping is often concealed beneath the floor plates, all valves should have their use designated by stencils on the wheel. The scheme of marking valves and pipes by means of tags has proven to be useless, as tags are easily lost after having been removed to facilitate repairs.

C. E. HARRISON.

Pittsburg, Penn.

I read with much interest the excellent article in POWER for April 26 on "Standard Colors for Stationary Piping." I have worked out the following for a small refrigerating plant: All live-steam lines, white; exhaust-steam, light blue; condensing-water and all fresh-water lines, bright green; fire-service, cherry red; air lines, granite gray; ammonia, both high- and low-pressure, navy blue; boiler-feed, blowoff and trap returns, maroon; conduits and all other pipes, black. Arrows should be painted at valves to indicate the flow.

This scheme is extensive enough to take in every thing needed about the average small plant.

GEORGE G. BENNETT.

Urbana, Ill.

Fuel Oil

In POWER for March 22, I read a reply to my inquiries regarding fuel oil. I am well aware of the fact stated by Mr. Axe that a fellow can get the desired information from textbooks, but the question is, are the data correct from a practical viewpoint? Are they correct as to working results? We know that the results of a test of specially designed apparatus conducted when the plant is in especially good condition do not coincide with those of a test made under the average working conditions of a plant.

My object in writing was, not for the purpose of having anyone dig up a lot of theoretical data, but rather for the purpose of getting operating engineers to tell us what they are doing and how they are doing it.

A description of what results were obtained in a plant of which I at one time had charge, may be of interest.

The boiler equipment consisted of two return-tubular boilers, 54 inches in diameter and 14 inches long. They were fitted with burners of my own make. I had water tanks arranged so that I could measure the quantity of water used at any time. The oil tank also was fixed so that the quantity of oil used could readily be ascertained. On some days of a ten-hour run, I could obtain an evaporation of 12½ pounds of water per pound of oil. On other days the results would be quite different. As the load on the boilers decreased, so also did the number of pounds of water evaporated per pound of oil, which sometimes went as low as 9½ pounds of water per pound of oil.

When operated at or near their rated capacity, the boilers gave the best results. When operated, as they were at times, at about one-half of their rated capacity, the efficiency decreased in proportion. Let us hear from more of our fellow operating engineers on the subject, for I repeat that it is only by an interchange of individual knowledge that we make ourselves better engineers, collectively and individually.

P. J. BRANT.

Fruitvale, Cal.

Why the Boiler Did Not Explode

In a recent issue, a correspondent inquires why a boiler, the plates of which were badly corroded, did not explode when the pressure was carried to a point obviously in excess of its safe working pressure.

The boiler probably was able to withstand the pressure because it did not have any cracks. Had even a slight rupture been present, the boiler would have failed, no doubt.

If anyone will take a piece of cloth by the edges and try to pull it asunder, my point may be illustrated by the difference in the force required to accomplish this when a slight slit has been made anywhere in the line of pull and at right angles to it.

A small crack in a plate of the boiler mentioned would, no doubt, have been sufficient to have caused the explosion which did not come. I have known of several boilers in operation under like conditions and this has been the only satisfactory explanation I have ever been able to get or offer.

A. A. BLANCHARD.

Oak Harbor, O.

Renewing Shaft Lining of Curtis Turbines

In the April 5 issue, H. Hughes tells how and why the shaft lining on a 2000-kilowatt turbine was replaced by a new one. While the methods of doing the work were not the worst that could be chosen, the reasons given for these are worse than the methods.

Because there was a rubbing of the buckets and a jingling somewhere about the step bearing, it was concluded that the step blocks needed renewal. It would be interesting to learn by what mental processes the conclusion was reached. When the step blocks were examined, it was found just as should have been expected from the behavior of the machine, that the cause of the trouble lay in the guide bearing instead of in the condition of the step.

Splitting the cut, worn sleeve to get it off the shaft was a waste of time, energy and a good sleeve for future use, for the intelligent application of heat would so expand the sleeve that it would drop from the shaft by its weight without the aid of pulling screws, just as the application of heat to the new sleeve so expanded it that it was easily pulled into position by hand.

Putting square-shanked studs into the square holes in the guide-bearing flange was a useless waste of the time and material used in making the studs. Round-shanked studs or even none at all will do as much good as all of the most closely fitting, square-shanked studs that it is possible to put in.

Studs or cap screws, whichever may be used, are put in solely for the purpose of holding the tapered shell in position under the temperature changes that might cause it to drop, and two are as good and as safe as twenty.

The sole cause of the excessive wear of the bearing, the filling of the water grooves and the scoring of the shaft bushing lay in the materials from which they were made, one of bronze and the other of babbitt metal.

No two metals in common use in machine construction are less fit to run together in shaft and bearing than these and if the engineer who works out the details of turbine construction does not know this the operating man into whose hands the machine is placed should, and he ought to be insistent in his demands that the bronze bushing on the shaft be replaced by a cast-iron one.

Reducing the length of the baffle worm and adding weight to the accumulator will not help matters nor will it increase the water pressure between the step blocks. When the pressure is sufficient to separate the step blocks any additional flow will only increase the distance between them without increasing the pressure, unless more water flows than can escape

through the bearing to the base without producing a back pressure about the outside of the blocks.

As nothing was said in the article about the conditions of the step blocks or of their renewal it must be taken for granted that they were not renewed. This leads one to ask for the reason why steps were taken to increase, unnecessarily, the load on the step pump?

Why, too, should the turbine be run only when impossible to get along without it?

JOHN S. KIRK.

Saugus, Mass.

Simple Lubricator Remedy

While reading over the subjects under discussion in the March 29 number, I noticed in particular the letter by Mr. Cultra on "Lubricator Improvement." When I have trouble with oil sticking to the side of the sight-feed glass and preventing the lubricator from feeding properly, I use a very simple remedy which I have found to give very good results.

After filling the lubricator, I blow out the water in the glass thoroughly, then I cut off the steam, take off the cap and pour in a little table salt.

Possibly some of the readers have used this remedy. I submit it for the benefit of those who have not.

W. A. WENTZ.

Butte, Mont.

Boiler Protection

In the April 5 issue of POWER I noticed a few statements in the letter entitled "Boiler Protection" which sound like errors to me. In regard to what should be done if the boiler pressure should get too high, the warning is given, "* * * as steam will be formed which after being heated to a high temperature will carry the heat directly to the boiler and an explosion will follow." If water on a fire will generate enough heat to explode a boiler, why cannot we take advantage of it? Why not turn the hose onto the fire under a boiler in which the pressure is below normal and in this way bring the pressure up rapidly? Water is cheaper than coal.

Water in the furnace might cool things too suddenly and make the fireman think that things were coming his way, but I do not think that it will generate enough heat to explode the boiler. I have always understood that it took heat to make steam and more heat to superheat it. This theory may have been exploded long ago, but I don't think so; anyhow, POWER has never mentioned it if it has.

Another error seems to have been made in this statement in regard to fusible boiler plugs, "This is a safeguard against boiler explosions but not against low water * *." I believe that the reverse is true. The pressure might get high enough to blow the safety valve through the roof, but it never would blow the fuse plug until the water level got below it.

I will describe one piece of carelessness which causes a lot of trouble in the boiler room. Imagine the boiler, the power magazine of the system, to be intrusted to a cotton chopper. He thinks the draft is not strong enough, so he takes out the damper and puts in a steam blower in one of his draft doors so he cannot close the doors. He works the boiler to the limit all day and then lets cold air rush through it all night. He keeps up this game for five or six years. Then a real fireman takes charge and runs the plant for a year or so when trouble with seams and tubes begins. About the first thing the manager will say is: "What have you done to it? That boiler never gave trouble before you took charge."

Undue exposure causing expansion and contraction strains is very injurious to any boiler.

R. E. HEUSLEY.

Hico, Texas.

A Compensating Gland

Referring to Mr. Le Fever's article on "A Compensating Gland" in the issue of April 12, I would call attention to the fact that a stuffing box of this kind would wear the rod to a taper because the greatest pressure would be exerted at the beginning of the stroke, while hardly any pressure would be present at the end. This is an objection to a number of the metallic packings which are in use at the present time. They always wear the rod much smaller at the piston end.

I have seen an idea like this tried on an engine piston. The steam at the beginning of the stroke was led by means of suitable passages, behind the rings and expanded them. It was abandoned, however, because it wore the cylinder unevenly and the rings leaked badly.

HAROLD JAMES.

New York City.

Trouble with Water Supply System

D. M. Medcalf, in the April 19 issue, asks for opinions as to the operation of his water system. I offer the following:

A 3-inch pump making 70 sixteen-inch strokes per minute will have a displacement of 34.3 gallons per minute. This is found by getting the product of the diameter of the pump in inches squared, the length of stroke in inches, the number of strokes per minute, and the constant 3.1416, and dividing by 924. The actual amount of water delivered will be somewhat smaller than this because of the slip, which amounts to from 5 to 8 per cent. for deep-well pumps. If we assume that the former value is correct, and divide 34.3 by 1.05, we get 32.67 gallons per minute for the actual amount of water delivered.

If this water flows to the tank, it must flow against a head of 100 feet, through 24 feet of 4-inch pipe, 1200 feet of 6-inch pipe, three ells and one valve. The head acting on the relief valve will be 100 feet plus that necessary to force the water through the pipe, ells and valve. The resistance of the pipe may be found from the formula given in POWER, page 996, December 14, 1909, which is as follows:

$$H = \frac{L Q^2}{10^6 K D^5}$$

where

H = Loss of head due to friction,
Q = Gallons of water per hour,
L = Length of pipe in feet,
D = Diameter of pipe in inches,
K = 3.05 for 4-inch pipe and 3.26 for 6-inch pipe.

This gives for H a value of 0.012 for the 4-inch pipe and 0.182 for the 6-inch pipe.

The head lost in the ells is found by the formula:

$$H = \frac{10 f v^2}{644}$$

where

H = Head in feet,
v = Velocity of flow in feet per second,
f = Coefficient of friction, which may be found in the following table:

Angle of Bend in Degrees.	30	45	60	90	120
Value of f	0.013	0.034	0.068	0.185	0.349

The head lost in valves is found from the same formula as for ells. For straight-way valves the value of f is the same as for a 45-degree ell and for a globe valve it is equal to that for two 90-degree ells.

Assuming the 4-inch valve to be a straight-way, the total head lost in the valve and ells is found, by the use of the preceding formula, to be about 0.005. In summing up, we have a head of 100.2 feet tending to open the relief valve. This is equivalent to 43.4 pounds pressure per square inch and as the valve is set for 50 pounds per square inch it will not be opened, and the water must be delivered to the tank.

J. M. ROW.

Fort Monroe, Va.

Buying Coal on a B.t.u. Basis

Under date of April 12, there appeared in POWER an abstract from an article by Wallace C. Rogers on buying coal on the B.t.u. basis. Mr. Rogers made some statements that were misleading. For the past five years I have been actively engaged in a line of work which brings me in daily contact with all sorts of steaming coal (bituminous) which I inspect and make tests of. I would like

to say a few words in favor of this method of buying coal and show the impracticability of purchasing on the plan suggested by Mr. Rogers.

To start with, his remark to the effect that the analysis is made from a quart of coal taken from a carload or several hundred tons is liable to create the impression that all that is done is to take this quantity of coal mentioned and make the analysis. As a matter of fact, when coal is properly sampled by anyone who understands this work, we get a very fair average, as can readily be determined by a comparison with samples taken from the face of the coal seam in the mine which are obtained by cutting a groove down the face from roof to bottom and collecting the coal thus secured.

Regarding the incident to which he refers, in which a clever salesman, after paying all of the penalties, made money on a coal contract, I will say that that contract must have been different from any that I ever saw, for in most of them the penalty is far more severe than the premium. The minimum B.t.u. value allowed usually eliminates the possibility of getting a coal below a certain heat value which is determined by the rate at which the boilers are worked. For plants where the boiler capacity is short and the boilers are forced above their rated capacity most of the time, there is a certain low value which cannot be exceeded else the coal will absolutely be refused.

With reference to his remark, "Then, why don't you buy a cheap gas coal that is absolutely useless as a steam coal, yet runs higher in B.t.u.?" I wish to say that there are a number of people in the coal and gas-making business who would be thankful to Mr. Rogers if he would tell them where they can buy a coal that has the requirements of gas coal and is higher in B.t.u. value than steam coal for less money than we are now paying for steam coal. Anybody who is selling a good gas coal for a steam coal at the prevailing prices of steam coal had better have his head examined.

Mr. Rogers' plan of having the coal man guarantee a certain horsepower-hour or kilowatt-hour to the engine or switchboard is out of the question for the reason that there are too many factors beyond his control that enter into the generation of power. The coal man would have to have charge of the plant in order to be sure the coal was getting a fair show. The efficiency of the entire plant must be considered in addition to the heat value of the coal before anyone can say with any degree of certainty what a certain coal will do in the way of producing power. Mr. Rogers' plan would simply relieve the power producer from all responsibility of keeping his plant up to a high point of efficiency.

The fact of the matter is, that while we have made rapid strides in perfecting boilers and engines and have spent practically all of our time with the details of these machines, we have not given enough of attention to the more important ends, such as the details of furnace construction and the burning of coal under different conditions. The average operating engineer who can interpret an indicator diagram with a moderate degree of correctness, thinks he is sufficiently well versed in his calling to stop right there. What we must do is to pay the same or more attention to the boiler room that we do to the engine room.

Let us pay more attention to flue-gas analysis, let the operating engineer become familiar with CO and CO_2 instruments, let us learn to make calorimetric tests of coal, let us not try to burn a highly volatile coal under conditions only suitable for a coal high in fixed carbons, let the fireman learn that the proper way in which to fire is frequently and lightly instead of every half hour which necessitates free use of the slicing bar, let us regulate the dampers to suit conditions more closely and let us work out other important details too numerous to mention.

In conclusion, I wish to say that the method of buying coal on the B.t.u. basis is perfectly logical when accompanied by specifications of a certain minimum heat value where this is made necessary by a limited boiler capacity, the allowable ash and sulphur contents and the proper regulations with regard to slack in screened coal and a fair and equitable premium agreement.

GEORGE W. BACH.

Conneaut, O.

Compression in High and Low Speed Engines

Under this heading in the April 26 number the question is asked, "In * * * case the piston speed is the same, * * * why should so much more compression and lead be required in one * * * than in the other?"

If the writer of the article will take into consideration the angular velocity of the crank pin as well as the linear velocity of the piston he will readily find the answer to his question. Piston speed is not a criterion. The steam distribution must be varied with the effect of the reciprocating parts, and the effect of the reciprocating parts varies with the square of the revolutions per minute.

The terms high and low speed are not applied to engines to indicate the piston speeds, which have but little effect upon engine problems, but are applied to compare the rotative speeds, which have a tremendous effect.

J. W. TAYLOR.

Massillon, O.

Boiler Explosions

In POWER for April 5, W. R. Willard comments on the fact that boiler explosions are but too frequent.

It is the business of the engineer to see to it that the internal pressure shall not exceed one-fifth of the strength of the boiler. An explosion comes suddenly because it is created suddenly. The chief cause of explosions is low water. When the water level gets below the fire plate or tubes, the steam gets enormously hot and dry and the pressure builds up very rapidly and the result is a disastrous explosion. I remember that on a fine Sunday morning in 1871 on the Staten Island ferryboat "Westfield," when the whistle cord was pulled for the boat to leave the slip, the boiler exploded and 106 men, women and children were scalded or drowned in the slip. If the feed pump had been working, the holocaust would not have happened; low water was the cause.

Once I was in a drafting office over a boiler that had the "heaves" at every stroke of the piston, but the coal tosser kept his water up to the mark and all went well. It was ten years after that before the boiler went to the scrap heap; it had been in service for 32 years altogether.

The fusible plug is an old English invention, but it is not a safe affair because the water has to be low before the plug is melted.

Mr. Willard tells a story of a man with a big hammer and presence of mind. Evidently he did not have low water or Mr. Willard's friend would have been small scrap meat.

I once carried, for five hours, a pressure 105 pounds above the 100 allowed by the inspector but I had 4.5 inches of water over my fire tubes and would have been willing to have carried the pressure another 100 pounds higher if it had been necessary. I knew the plate, rivets and workmanship.

In the seventies, a friend of mine on a Chicago tugboat had been carrying 90 pounds pressure on the boiler all day. As the boat was being laid up for the night, he was suddenly ordered to get ready to go out again. As the boat was leaving the dock, the boiler exploded and both friend and boat were lost. The pressure in the boiler, when last observed, was only 10 pounds.

The arrangement shown in Fig. 2 of Mr. Willard's article is all right but it should operate a bell mechanism rather than a whistle, for when the water level is low any withdrawal of steam lowers the water level and increases the danger of the situation.

PETER VAN BROCK.

Jefferson, Ia.

Boiler Explosion at Canton, Ohio

At 2 p.m., Tuesday afternoon, May 17, there occurred a most terrific boiler explosion at the plant of the American Sheet and Tin Plate Company, Canton, O., in which thirteen men lost their lives and forty more were injured. The explosion, which could be heard for miles, shot mill men into the air and tossed them in all directions. In a twinkling, human beings, some burned and scalded beyond recognition, lay either dead or in the throes of death on the ground in the vicinity of the plant. The big works, covering several acres, resembled a scene of carnage, and the west side of the main building nearest the boiler room was completely wrecked.

The plant had five mills. Employees working in mills Nos. 1, 2, 3 and 4 got the full force of the explosion, while the men in mill No. 5, farthest from the boilers, escaped with minor injuries.

To its destructive force the explosion added several unusual features, the most striking one being the manner in which the body of William Austin, the fireman on duty at the time, was blown like a cannon ball a distance of several hundred feet, over a number of buildings, completely through the second story of a residence, tearing cleanly through both walls, out the other side, and through a fence in an adjacent yard, finally landing on the ground and tearing up a wide furrow. The engineer also was killed.

The top sheet of the boiler which exploded was hurled 1000 feet over the top of a building into a field beyond. A twisted steel bar dropped like a bomb through a residence 300 feet away. The concussion was so great that houses within a radius of half a mile suffered heavily from broken windows.

Thirteen dead and forty injured, some fatally, is the toll inflicted by the most disastrous boiler explosion which has occurred in s veral years. The boiler, which was an Erie City, return tubular, was 15½ years old, carried a pressure of about 90 pounds, was insured and had been inspected as late as January 28, 1910. Almost every rivet in the boiler, both along the longitudinal seams and the curvilinear seams at the heads, was cleanly sheared off. The metal of the plates and heads was in unusually good shape, the rivet material was apparently good, and the tubes and stays were not in bad condition. All data obtainable point to a sudden and enormous overpressure, probably due to cutting the boiler in on the line too rapidly.

The boiler house was an L-shaped addition to the main building and contained seven boilers of the horizontal return-tubular type numbered from 1 to 7. No. 2 boiler is the one that did the damage, throwing No. 1 to one side and lifting No. 3 out of its setting completely over the battery of boilers and landing it alongside of No. 7. The settings of the remaining boilers were demolished and the piping and other arrangements in the boiler house were totally wrecked. It was found that No. 3 boiler was ruptured, due to the concussion of No. 2, in which it is generally agreed the primary action took place.

History of Boiler

As to the history and physical characteristics of No. 2 boiler, it developed on investigation that the boiler was built by the Erie City Iron Works, and inspected at the shop when new, October 1, 1894, by the Hartford Steam Boiler Inspection and Insurance Company, making it about 15½ years old. It was placed in service at the steel mill at Cambridge, O., where it remained until October, 1909, when it was moved to the present plant. The boiler was inspected by the Hartford company on October 4, 1909, just prior to its removal from Cambridge; again on October 15, upon arrival at Canton, and finally on January 28, 1910, when it was allowed 100 pounds pressure. Insurance by the above company was carried at the time of the explosion.

Fig. 1. Scene of Wreckage Looking Directly Toward Site of Exploded Boiler

Technical Details

The boiler was 5 feet 6 inches in diameter by 16 feet long and was built of two sheets of ⅜-inch steel of 60,000 pounds tensile strength, one single sheet forming the bottom and one the top, the sheets being joined with a double-riveted lap seam on either side, using ¾-inch rivets in 13/16-inch holes pitched 3 inches on centers. The tube sheets were of 7/16-inch material and were stayed above the water line with twelve ½x2-inch diagonal stays with one finger, as distinguished from the ordinary crow-foot stay.

Examination by the writer was made after the various pieces had been collected inside the mill. The first fact to be noted was that almost every rivet in the boiler, both along the longitudinal seams and the curvilinear seams at the heads, was cleanly sheared off and that the plates themselves had not failed at the joint, nor did they show the slightest indication of cracks at the seam, such as are developed in lap-seam explosions. The metal of the plates and heads was in unusually good shape and showed no signs of crystallization or lamination. There was a total of 248 rivets to be sheared in the longitudinal seams. The rivets in both heads were sheared in an equally complete manner. All testimony that developed indicated that the rivet material was good. The boiler contained seventy 4-inch charcoal-iron tubes and all of them available for examination appeared to be in as good condition as could be expected after passing through such an explosion.

It was not possible for the writer to determine that any one part of the boiler let go first, but from the appearance of the pieces the impression was gained that such havoc in a boiler with the sheets, tubes and rivets in such apparently good commercial condition, could have been caused only from the generation of a sudden and enormous overpressure, causing the boiler to let go in all directions at once. No sign of overheating was observed on examination. A fortunate circumstance in this connection was the fact that the rear tube sheet was bent double on itself through the center line of the top row of tubes, just where the metal would first be affected by low water.

That the metal at this point stood the test without cracking is about as good evidence as it would be possible to submit that low water had not injured this boiler.

Some criticism was made in regard to the stays, which it was claimed were too light for the boiler. While they were not as good as the diagonal stays made today, as might naturally be expected, inasmuch as they were made fifteen years ago, still at the inquiry no one seemed to think that they could have been the primary cause of the explosion. Had the heads blown out first it is reasonable to suppose that the greatest force of the explosion would have been endwise and that very possibly, in view of the excellent condition of the shell, the longitudinal seams would not have let go. The fact remains, however, that every seam in the boiler let go, apparently as the result of an irrestible force instantaneously applied in all directions.

Investigation of Cause

Immediately following the explosion Coroner Harry A. March instituted a vigorous investigation as to the cause of the disaster and summoned all officials of the company and employees who might by any possibility know anything of the boilers and their condition at the time of the accident.

The testimony brought out the fact that Monday night before the explosion, No. 2 boiler had been cut out on account of the sticking of the check valve in the feed line and a slight leaking in the nipple connecting the safety valve with the boiler. It was demonstrated that before this boiler had been cut out Monday night, the 3-inch pop safety valve had blown freely at a pressure of about 95 pounds.

No. 2 boiler was off all Tuesday morning while the check valve was being repaired, the six other boilers being in service, and it was supposed that No. 2 was cut in at about the time the explosion occurred. All testified it to be their belief that the general condition of the boiler was good.

On the following day the coroner requested Francis B. Allen, of Hartford, Conn., vice-president of the Hartford Steam Boiler Inspection and Insurance Company; Osborn Monnett, of Chicago, Western editor of Power, and Edwin W. Wheelan, of Canton, a local boilermaker, to inspect the plant and report their opinion as to the cause of the accident.

Mr. Allen's Report

On being sworn by the coroner, Mr. Allen testified that as far as he had been able to investigate he was of the opinion that a combination of circumstances, such as would produce a violent shock or water hammer, was the most logical explanation of the catastrophe, when taking all the conditions into consideration.

He explained that such a combination of circumstances might arise through the attempt to cut in No. 2 boiler either at a lower or higher pressure than that in the line.

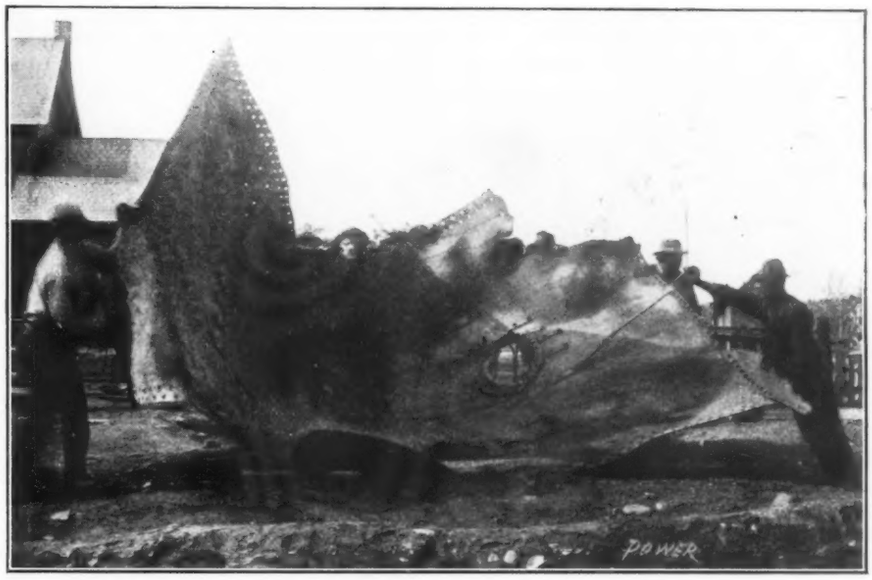


Fig. 2. Top Half of Boiler Which Was Blown 1000 Feet

Mr. Monnett's Report

In testifying before the coroner, Mr. Monnett said he believed that the rapid cutting in of No. 2 boiler at a pressure greater or less, probably greater, than the line pressure, would, in view of all the existing circumstances, more nearly account for the explosion than any other theory.

In this connection it was brought out that Hughes, the water tender, was absent from the boiler room at the time of the explosion, and that in his absence Austin, the fireman, would be required not oniy to tend water but do anything else that required doing; that Austin was the man who was blown farthest from the plant; that he must have been in an exceptionally favorable position to receive the full force of the explosion—in other words, on top of the boiler; that he must have been in an elevated location to start with, otherwise he could not have been blown over several adjacent buildings, some of which were very close to the boiler room, before striking the ground; that had he

been standing on the ground his body would have been found nearer those of the other men; that the only reason for being on top of the boiler was to cut it in, and that the boiler was needed to carry the load and the men were in a hurry to get it on the line. To strengthen this belief the Denver case was cited.

Mr. Wheelan's Report

Mr. Wheelan said he believed, as a result of his observations, that the explosion was due primarily to low water. He based this belief on the result of an earlier visit to the plant when he said he saw twelve or fifteen tubes which had the scale removed and which showed the metal blue, indicating, in his opinion, that they had been overheated. He explained the fact that the back tube sheet did not show blisters or deterioration by saying that it did not have time to get burned before the explosion occurred. However, he believed that the back tube sheet had been hot, from the fact that there was little or no scale on it.

Mr. Wheelan said that he did not think low water in itself would cause the explosion, but thought that introducing feed water at that time would set up stresses sufficient to disrupt the boiler. He also criticized the stays, saying he did not believe they were strong enough or in good enough shape to stand 100 pounds of steam.

According to Mr. Wheelan's theory, Austin would of necessity have been on the ground manipulating the feed valve. He did not see how Austin could have been hurled in the peculiar manner in which he was, under these conditions.

Hughes, the water tender, who was in the store room at the time of the explosion, was injured and taken to Altman hospital. After the above testimony was taken his condition was such as to permit the coroner to take his deposition, which was substantially as follows:

Fig. 3. View of Plate Shown in Fig. 2 Taken from Opposite Side

Hughes' Story

Mr. Hughes said that he had come on duty at 6 a.m., Tuesday morning. At 9 o'clock he had cut in No. 1 boiler, which had been cut out to have the blowoff repaired, and worked the rest of the morning in getting the check valve clear on No. 2, pumping up and blowing down several times to be assured that it operated satisfactorily. Finally the boiler was filled with two gages of water at the temperature of the heater, about 180 degrees, and a fire was started about 12:45 p.m. At about 1:40, or 55 minutes later, the boiler blew off at 95 pounds and very soon after he cut it into the line at a pressure of 88 pounds, approximately 20 minutes before the explosion.

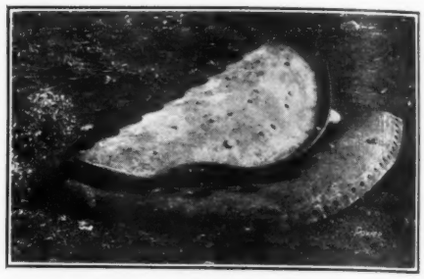


Fig. 4. Back Head Bent Double on Center Line of Top Row of Tubes

Mr. Hughes said that the leak in the nipple under the safety valve was of slight consequence. He stated that when he left the boiler room Austin was standing between No. 3 and 4 boilers, some distance from No. 2. He was certain that he had cut the boiler in and that there was plenty of water in it at the time. He was not able to advance any reason for the explosion as he had always considered the boiler perfectly safe.

Several parts of safety valves were collected but were not in condition to be tested. The valve from No. 4, however, which was uninjured, was tested by hydrostatic pressure and found to blow at exactly 100 pounds.

At the present writing the coroner has not rendered a verdict on the disaster.

Cleaning with Gasolene

The cotton work gloves, the "six-pairs-for-a-quarter" kind, are most excellent for shopwear, but they will get so dirty that the wearer is often puzzled which side out they could be worn to the greatest advantage. A wash in gasolene will quickly remove the grease and most of the other dirt, but look out when you try this wrinkle and not get caught as one man did.

He washed the gloves in a pint of gasolene in a dish and threw the dirty hydrocarbon out of the door upon the ground. Just then he thought it would be amusing to see the gasolene burn, so he thoughtlessly lit a match in the old convenient way, intending to throw the blazing bit of wood into the spilled gasolene. But he didn't have time for that. Instantly his gloves, which were on his hands, were all ablaze. He made two flops with his hands, for he didn't lose his head for a second, even if he did lose his gloves. One of the gloves flew off at the second "flop," but the other stuck half way on. The man stooped quickly, stepped on the fingers of the blazing glove and drew it off his hand so that not a bit of skin was even scorched.

Semi-Annual Meeting of Ohio Society

The twenty-first meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers was held at the Sinton hotel, Cincinnati, O., on May 19 and 20, 1910. The various sessions were presided over by President Oscar Rabbe, Toledo, O. There was a very good attendance, and quite a number of accessions to the membership.

The following papers were read: Selecting a Boiler, by F. C. Bitgood, sales manager, Cincinnati office, Babcock & Wilcox Company; The Scientific Treatment of Boiler Feed Water, by Herbert E. Stone, sales manager, Dearborn Drug and Chemical Works; Metallurgical Considerations in the Manufacture of High-pressure Valves and Fittings, by George K. Elliott, chief chemist, Lunkenheimer Company, Cincinnati, O.; Centrifugal Pumps, Their Uses and Limitations, by L. G. Finlay, engineer-salesman, Cleveland, O.; The Kinney Positive Pressure Rotary Pump, by C. O. Thurston (non-member), of the Kinney Manufacturing Company, Boston, Mass.

Some of these papers appear in abstract in the present report and the others will be published at an early date.

Thursday afternoon was occupied by a trip to the Lunkenheimer plant, to which the members and guests were conveyed in special cars, and where they took luncheon. They were looked after by Samuel L. Moyer, general manager, Superintendent Ritter and others at the plant, who showed them every attention and courtesy.

Selecting a Boiler

Mr. Bitgood's paper given at the Thursday night session brought out a very interesting discussion. Various phases of individual preference were expressed either for the tubular or water-tube form of boiler construction, but nothing new was developed that is not already conceded for each type. The recent explosion at Canton seemed to emphasize the safety feature and this was discussed at some length. An abstract of the paper follows:

In his introductory remarks, the author draws a comparison between the water-tube and return-tubular boilers. He naturally favors the former and refers to its ability for quick steaming, the comparative safety of the water-tube boiler, accessibility for cleaning and the economy obtained by introducing a reasonable degree of superheat.

Continuing, the author states that the most rational way of selecting a boiler is to find out what boilers are successfully used for the class of work under consideration, and if engineering practice quite universally has adopted one or another style of boiler, it is usually safe for the purchaser to adopt this style. Having selected the general type, or having settled on one particular type, the next step would be to purchase at as satisfactory terms as possible. Again, if boilers of a certain class have been used with eminent satisfaction in a plant and it is desired to make an extension, the fact that the operating crew are satisfied and well acquainted with the operation of the boilers already at the plant, should be given due consideration. By following this plan the purchaser is safeguarded, but there always will be new boilers placed on the market for which great claims will be made, and which may perhaps be purchased at a lower price than other boilers, which have been tried out and shown to give reliable results. If one of this class of boilers is purchased, it might, on the one hand, turn out to be a good investment, but on the other hand it might not. It is a fact that all of the best builders have found it necessary to considerably modify the design of their boiler, after having first placed it on the market, in order to eliminate certain defects which can only be found after long periods of actual service.

The mere fact that the majority of boilers placed on the market have eventually disappeared, whereas others that were largely used before the new designs were brought out are still used and continue in favor, shows that there must be some inherent advantages in the well tried and older forms. To sum up the situation, the purchaser cannot go far astray by selecting a boiler which has given satisfaction in years of service for the particular class of work at hand, whereas should he purchase a comparatively untried boiler he may have to pay for his experience and be disappointed.

There are still engineers who believe that "any old thing" will do in the way of a boiler, and it is this feeling that those dealing with the higher classes of apparatus often have to contend with. Make sure you have a safe boiler, make sure that it has already given good satisfaction in long service and that it is recognized among engineers as a standard. If you wish to take chances by using a comparatively new boiler, call in the highest expert skill if an expert is not available in your organization, but do not assume that the problem is a simple commercial one where the lowest bidder or the one guaranteeing the best efficiency should be awarded the contract.

The Scientific Treatment of Boiler Feed Water

In the absence of Herbert E. Stone, his paper was read by Secretary Sanborn, and was given some discussion which would have proceeded to greater length had not the lateness of the hour prevented it. The substance of the paper follows:

For present intents and purposes, we may consider all waters to have their origin in either the sea or lakes; from which it is drawn up in the form of vapor by the action of the sun and when condensed, produces rain. In its descent, the rain takes up some of the constituents of the atmosphere, notably carbon dioxide, ammonia, nitrogen and, in some localities, sulphuric acid.

Natural waters are impregnated with the salts of lime, magnesia, sodium, potassium, iron, silica and aluminum, any or all of which may be in the water to a greater or less extent, depending upon the nature of the soil.

The more common troubles experienced in the operation of steam boilers, and attributable directly to the feed water, are incrustation, corrosion, pitting, foaming and priming, bagging of sheets or tubes, and destruction of gaskets.

The salts of lime, magnesia, iron and silica are scale-forming ingredients. Sulphate of lime (gypsum) forms a very hard and compact incrustation, adhering tenaciously to the hot metal. It is very difficult to break up, decompose or dissolve, and like all sulphates it is very stable. The only substances which can be successfully used in a boiler to convert this salt into a form in which it can be readily washed out are saccharine substances properly blended. When used under the high heat and conditions existing in a steam boiler, these convert the sulphate of lime into a complex mixture of saccharates and carbonate of lime, and this latter, in the presence of tannin compounds is partially converted into tannates of lime.

Carbonates of lime and magnesia enter into the scale formation as such, and form a very compact incrustation. But they can be readily converted into a mixture of tannates of lime and magnesia without any contamination of the steam or injurious effect upon the metal of the boiler.

Another substance commonly found in water is sulphate of magnesia, better known as "Glauber's salts." This is very soluble in water under all conditions and seldom forms an important factor in scale formation.

Chloride of magnesia has a very corrosive effect upon iron. It is unstable, readily decomposed by heat into oxide of magnesia and chlorine; the former producing scale and the latter, in combination with hydrogen, forming hydrochloric acid which has a direct corrosive action upon the iron.

Sulphates of iron and copper are not common to waters other than those near mining districts. Under the conditions existing in a boiler, these salts are decomposed into oxides of iron and copper; which being insoluble become incorporated with any scale formation that takes place. All sulphuric acid, formerly combined with the iron and copper is liberated, and even though the water originally contained no free acid, it by this process assumes a decidedly acid reaction and becomes extremely corrosive.

The deposit of scale on boiler tubes and sheets is of great importance, for two reasons: first, its effect upon the cost of maintenance and repairs; second, its effect upon the fuel consumption. An idea of the importance of the second consideration may be had from the following results taken from a series of reliable and authoritative tests under practical operative conditions.

EFFICIENCY LOSSES.

Character of Scale.	Thickness, Inches.	Composition.	Loss Per Cent.
Hard	1/10	Mostly carbonate	9.4
Soft	1/12	Mostly carbonate	7.2
Hard	1/12	Mostly carbonate	8.5
Soft	1/32	Mostly carbonate	8.0
Hard	1/16	Mostly sulphate	11.1
Soft	1/16	Mostly sulphate	10.8
Hard	1/16	Mostly carbonate	12.6
Soft	1/32	Mostly carbonate	15.0
Hard	1/8	Mostly sulphate	15.9

From the above table it is apparent that the loss is not always dependent upon the composition of the scale, but frequently upon the physical conditions.

Corrosion often takes place beneath the scale formation and unless revealed by a careful examination and proper precautionary measures are adopted, it will perforate the metal.

Many different theories have been advanced as to the direct cause of corrosion in the form of pitting and disintegration of the metal, but according to those best suited to render an opinion, it is due to a galvanic action. This is produced by the metal of the boiler and fittings acting as poles, with pure water or water containing sodium salts, as the electrolyte. This action is easily broken up by treating the water with some vegetable starch or saccharine matter.

Many chemists or agents of boiler compounds attempt to make money upon a very little knowledge of the subject. They can think of nothing to cut the salts of lime and magnesia or general scale formations except caustic soda, soda ash, sal ammoniac or copper salts. These antidotes, usually used in large quantities, while acting upon the scale, at the same time are apt to have an injurious effect upon the metal. Also they may be carried over into the cylinder by the steam, and as a result cut the cylinder oil, blacken the rods and play general mischief with the piping. This lack of proper research and thorough experiment has caused the boiler compound subject for years to be badly butchered, resulting in the manufacture of various nostrums consisting of mixtures of soda or other alkaline salts.

The only safe way is to make a careful analysis of the water, and taking into consideration the particular conditions existing at the plant, resort to the use of such chemicals as are deemed most suitable, at the same time using only such proportions and methods of application as are most advantageous.

Friday Morning

At the Friday morning session an invitation was tendered the convention by the Lodge & Shipley Machine Tool Company, Cincinnati, to inspect their plant. On motion of Dan Delaney six associate and 21 active members were elected.

An invitation to hold the next convention at Springfield, O., was received and read, from A. D. Hosterman, chairman of Franchise and Conventions, of that city. The chair stated that ex-Secretary Gaehr warmly indorsed the invitation. The matter was laid over to the evening session.

President Rabbe called especial attention to work of the Research Committee of the society, which is endeavoring to collect reliable data on the cost of handling coal and ashes in power plants of varying types and conditions. He urged that all members fill out report blanks and forward them to the committee in order to assist their work.

Metallurgical Considerations in the Manufacture of High-pressure Valves and Fittings

The remainder of the morning was occupied by George K. Elliott, chief chemist, Lunkenheimer company, whose paper was illustrated by lantern slides, and proved exceedingly entertaining and instructive. Mr. Elliott, in connection with his talk, showed samples of metal valve bodies manufactured by various concerns in this country and abroad, and which he tested in the presence of the convention with the scleroscope. Mr. Elliott showed that it was impossible for any firms manufacturing valves to produce the same results with inferior alloys that can be produced by high-class manufacture. The samples shown by Mr. Elliott had the following percentages of alloys:

Sample No. 1. Copper, 87 per cent.; tin, 5 per cent.; zinc, 2 per cent.; lead, 6 per cent. A very good metal except for the lead. Hardness, 20, which falls short.

Sample No. 2. Canadian made valve; copper, 80 per cent.; tin, 3 per cent. (low on tin); zinc, 9 per cent.; evidently substituting zinc for tin; lead, 8 per cent.; hardness, 17.

Sample No. 3. Canadian made; copper, 83 per cent.; tin, 2 per cent.; zinc, 12 per cent.; lead, 3 per cent.; another in which zinc was substituted for tin; hardness, 10.

Sample No. 4. American made; copper, 87.5 per cent.; tin, 4.5 per cent.; zinc, 4.5 per cent.; lead, 3.5 per cent.; this the speaker pronounced the best of the lot, but low on tin and slightly high on lead; hardness, 21.

Sample No. 5. The worst of the lot. American made; copper, 73 per cent.; tin, 5 per cent.; zinc, 10 per cent.; lead, 12 per cent.; hardness, 15.5.

Sample No. 6. English made; copper, 82 per cent.; tin, 7.5 per cent.; zinc, 5 per cent.; lead, 5.5 per cent.; plenty of tin, although a costly mixture spoiled by using too much lead; hardness, 21.

Slides exhibited by the speaker showed the evolution of the steam metal from copper down to the finished product as it passed through the different stages, showing difference in structural appearance when subjected to microscopic examination, as affected by successive additions of tin, zinc and lead. Also slides showing microscopically the different structural effects produced by casting at correct and incorrect temperatures, and a series of slides showing the different effects structurally produced by varying the condition of the molding sand as to moisture content.

Upon the conclusion of the foregoing paper the members and guests left on special trolley cars for the Triumph Electric Company's new plant at Oakley and that of the Philip Carey Company, at Lockland.

Centrifugal Pumps, Their Uses and Limitations

At the Friday night session the first order of business was the paper by Mr. Finlay, but owing to the absence of the writer, this was passed. A summary of the paper follows:

Although much has been written upon the design and application of centrifugal pumps, there is still a lamentable lack of knowledge of such pumps among the majority of operating engineers.

There are many kinds of service in which the conditions are such that only a centrifugal pump can be used efficiently. In the irrigation of land where enormous quantities of water have to be handled against low heads, the reciprocating pump has absolutely no chance in competition with the centrifugal pump. This is also true in contracting work where it is necessary to pump a considerable quantity of water mixed with dirt, gravel and other foreign substances. Again, for the supply of large manufacturing plants where large quantities of water are required under comparatively high heads, the reciprocating pump is being rapidly displaced for the reason that it is costly to maintain as compared with a centrifugal pump.

While it might not be claiming too much to say that for every service in

which there is a reciprocating pump, a centrifugal pump can be used; it is not advisable to follow this in extreme cases as, for instance, the delivery of a small quantity of clear liquid against a low head is generally best performed by a reciprocating pump, owing to the fact that the latter can be built very cheaply. Also, in delivering a small quantity of water against a very high head it would be a poor commercial proposition to employ a centrifugal pump owing to high cost involved.

A point which is of vital interest yet not generally understood is the necessity of being exact as to the duty which a pump has to perform. These duties, such as quantity of water to be handled and the exact head to be pumped against, must be known before the pump is designed, in order to take advantage of the characteristic curves most suitable for the service. A number of cases where centrifugal pumps have fallen down have been investigated by the writer and invariably it was found that there had been a lack of exact information regarding the conditions under which the pumps were to be operated.

The layout of piping for a centrifugal pump unit should be given careful attention. The speed in the discharge pipe should not exceed 200 feet per minute, while the rate of flow through the pump should be from 8 to 10 feet per second. Changes in size from the pump flange to the piping should be effected by means of tapered reducers and all turns should be made by means of long-radius bends.

It may be of interest to give an idea of the efficiencies obtainable with centrifugal pumps. While the following list is approximate, for the various sizes, it can be taken as practically standard.

1- to 2-inch	45 to 48 per cent.
3-inch	50 per cent.
4-inch	52 to 55 per cent.
5-inch	55 to 58 per cent.
6-inch	60 to 66 per cent.
8-inch	63 to 68 per cent.
10- and 12-inch	68 to 70 per cent.

From the above it will be seen that the efficiency increases with the size. The writer knows of one 24-inch pump which after one year's operation on irrigation work showed an efficiency of 80 per cent.

Friday Evening Session

Action upon the invitation to hold the next convention at Springfield, O., was referred to the council for future consideration, with power to act. H. D. Pownall's paper was then presented, and a little later C. O. Thurston read his paper on The Kinney Positive Pressure Rotary Pump. In addition to lantern-slide illustrations Mr. Thurston showed the interior construction of the pump from a small model. Both of these papers will appear in a later issue.

After the adoption of the usual votes of thanks to the local committee, the press and others, the convention adjourned *sine die*.

Those remaining over Saturday were treated to a trip to the new water works at California, O., confessed to be among the finest in the world, and were entertained by the committee at luncheon at the California hotel; the turbine plant of the Cincinnati Traction Company was also visited.

Much credit is due for the general smoothness of the running of the convention to the general Committee on Arrangements: L. T. Kaiser, chairman; Samuel L. Moyer, F. C. Bitgood, William Mittendorf, Dan Delaney, H. D. Pownall, E. M. McClintock.

Balancing Thrust of Propeller

By Dr. Alfred Gradenwitz

The arrangement herein described was recently developed by Brown, Boveri & Co., of Mannheim, Germany, and is applicable to marine turbines in cases where the auxiliary turbines are connected to the main turbine shaft through a clutch. It consists mainly of relieving surfaces in the main turbine arranged for compensating the additional back thrust produced by throwing in the auxiliary turbine.

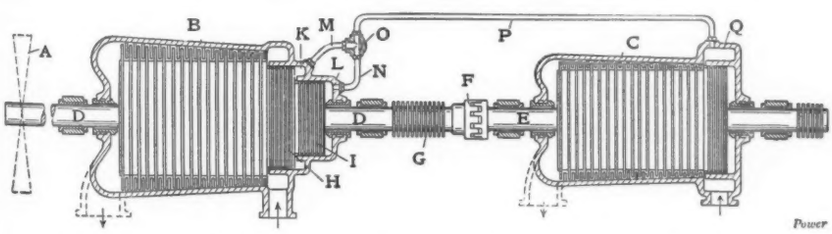


FIG. 1. SECTION SHOWING COMPENSATING ATTACHMENT

Fig. 1 shows a longitudinal section of a marine-turbine unit arranged in accordance with the above scheme, while Fig. 2 is the same main and auxiliary turbines but without the compensating attachment.

Referring to Fig. 1, *A* represents the propeller, *B* the main turbine and *C* the auxiliary turbine. The shafts *D* and *E* of the two turbines are connected together by a clutch *F*, which is subject to an axial thrust. The thrust bearing *G* is situated on the shaft *D*. The main turbine is fitted with a relieving piston consisting of two stages *H* and *I*. The compartments *K* and *L* are connected with the governing valve *O* by the pipes *M* and *N*. From this governor a third connection *P* leads to the steam-admission compartment *Q* of the auxiliary turbine.

The working of the arrangement is as follows:

When only the main turbine is operated, the governor *O* is set so that the compartments *K* and *L* are communicating with one another, cutting out the connection *P*. As the steam thrust of the main turbine is compensated by the opposite propeller thrust, the staging of the relieving pistons is of no importance in this case.

If, however, the auxiliary turbine be thrown in, it will increase the thrust acting in an opposite direction to that of the propeller. This additional amount would ordinarily be dealt with by the thrust bearing. The new arrangement, however, is intended to relieve the thrust bearing and thereby permit a reduction in its dimensions. This is effected by connecting the compartment *K* with *Q* through the governor and piping as shown, the connection *N* now being closed. There is now steam acting in opposite directions on *H* and *I*, the pressure on *I* partly offsetting the balancing effect ordinarily produced by *H;* thus there is an excessive thrust of the propeller which in turn is compensated for by the opposite thrust of the auxiliary turbine.

The magnitude of the thrust produced by the steam pressure on the piston *H* can be controlled at will by a convenient adjustment and design of the governing valve *O*.

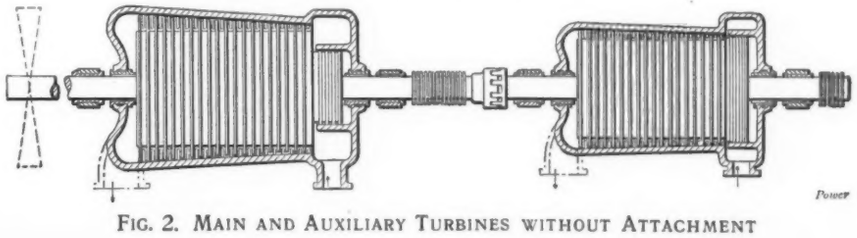


FIG. 2. MAIN AND AUXILIARY TURBINES WITHOUT ATTACHMENT

Boiler Explosion at Chewtown, Pa.

By Osborn Monnett

An old tubular boiler which had been twice discarded and had been exposed to the elements for a number of years was picked up by its present owners and installed about nine months ago. As it was badly patched and contained defective stays, the inevitable explosion occurred, killing three men, seriously injuring six other persons and causing a property damage of $25,000.

At 9 a.m., Sunday morning, May 15, a boiler explosion occurred at Chewtown, a small mining village one mile south of West Brownsville, on the Washington county side of the Monongahela river, in which three men were killed and six other persons, including one woman living near the scene of the explosion, were seriously injured. The boiler plant belonged to the Diamond Coal and Coke Company and consisted of a battery of five boilers, three of which were of the flue type used on river boats and two ordinary return-tubular boilers in standard brick settings, one of these being at each end of the battery. The boiler which exploded was the return-tubular standing at the left in the row, and while the others were all shaken from their foundation and dismantled, as evident in Fig. 1, their shells were apparently uninjured. The boiler house itself, consisting of heavy timbers and masonry, was completely demolished, along with the coal tipple belonging to the company. Three nearby dwellings were consumed by the fire which followed the explosion, all the household effects of the occupants being destroyed. The property loss is estimated at about $25,000.

The boiler which exploded was 60 inches in diameter by 16 feet long, and contained 54 four-inch tubes. It was made up of 5/16-inch plates, with double-riveted lap-joint longitudinal seams, using ¾-inch rivets in 13/16-inch holes pitched 1⅞ inches from center to center. The heads were of ½-inch steel plate. In addition to this ordinary construction the boiler was fitted with a large horizontal steam drum 32 inches in diameter by 8 feet long, connected to the shell through two 12-inch necks. The manhole was in the rear course, as shown in Fig. 3.

Owing to the fact that the boiler was blown almost completely to pieces, some parts of which have not yet been found, it is somewhat difficult to analyze the cause of the several ruptures, but a study of the condition of the parts and as much of the history of the boiler as is available, serves to indicate with reasonable accuracy about the order in which the fractures occurred.

As far as could be ascertained, the boiler had first been used in Brownsville across the river and had been discarded, lying idle for some time. Finally it was installed in an ice plant in West Brownsville and saw considerable service there. This plant burned down about five years ago and the boiler lay idle again, exposed to the elements, for over four years. About nine months ago it was installed in the present plant.

Examination of the metal showed it to be in fair condition as far as the original plates were concerned. However, on the bottom of the boiler, extending into the middle and front courses, there was a patch of ¼-inch metal in extremely bad condition. This patch tapered off at one edge to not more than ⅛ inch in thickness, and at one spot the metal was drawn to the thinness of a knife edge and ruptured. This spot also showed signs of overheating, but as the piece was resting on the site of one of the burned dwellings and had passed through this fire, the heat of the conflagration might easily have burned the thin edges of the ruptured patch. This point, directly on the bottom of the boiler, was undoubtedly the location of the initial rupture, and additional proof is furnished by the fact that the greatest force of the explosion was directed upward.

The steam drum was blown on top of a hill over 200 feet high and landed in two pieces, fully a quarter of a mile from the plant. Figs. 4 and 5 show these parts. The drum broke in two at the curvilinear seam, and the two pieces landed within 500 feet of each other. Another peculiarity of the explosion was the fact that the back course pulled completely away from the rest of the boiler around the circular seam, and also let go longitudinally through the center line of the manhole. Fig. 2 shows this piece.

Examination of the stays in both ends showed them to be in very bad condition. The stays were of inch-round material, of the diagonal crow-foot pattern, and in nearly every case were found broken off, the breaks showing old fractures in most instances, with only a small percentage of the metal holding. One of the broken stays showed a bad state of crystallization, and some of them broke not only in the round section, but also pulled apart at the point where they were riveted to the shell. The condition of

FIG. 1. GENERAL VIEW OF WRECKED BOILER PLANT

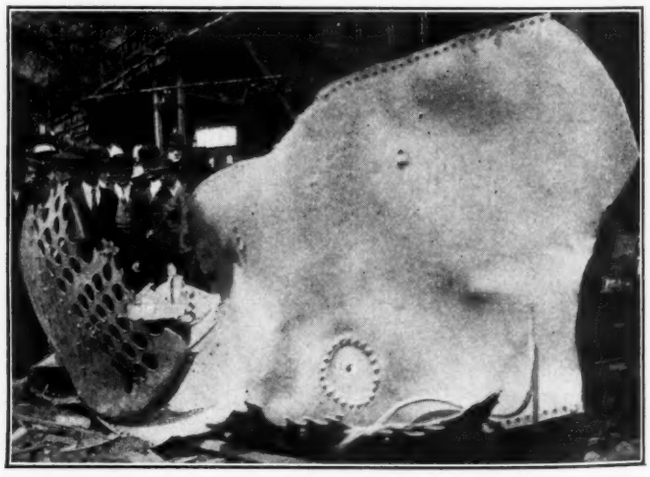


FIG. 2. REAR COURSE AND HEAD

the stays alone would have been enough to make the boiler unsafe for use irrespective of the weakness of the patch on the bottom of the shell.

The pressure carried was 110 pounds. All the remaining boilers were fitted with old-type lever safety valves, and it is assumed that the exploded boiler was also fitted with this type of safety valve. A light load, consisting of fan engines and pumps, was being carried and the fires were practically banked. It is known to a reasonable certainty, however, that at least two boilers were under steam.

One of the workmen who lives near the plant stated that he had frequently heard the safety valves blow, indicating that they were in fair working order, but was certain that he had not heard the valves blow on the morning of the explosion.

From the evidence, overpressure had nothing to do with the disaster, and in view of the enormous energy set free, low water could hardly have been to blame. As a matter of fact, the boiler was in an extremely unsafe condition and was in no shape to stand normal working pressure. It goes without saying that no boiler insurance was carried and that no inspection had been made.

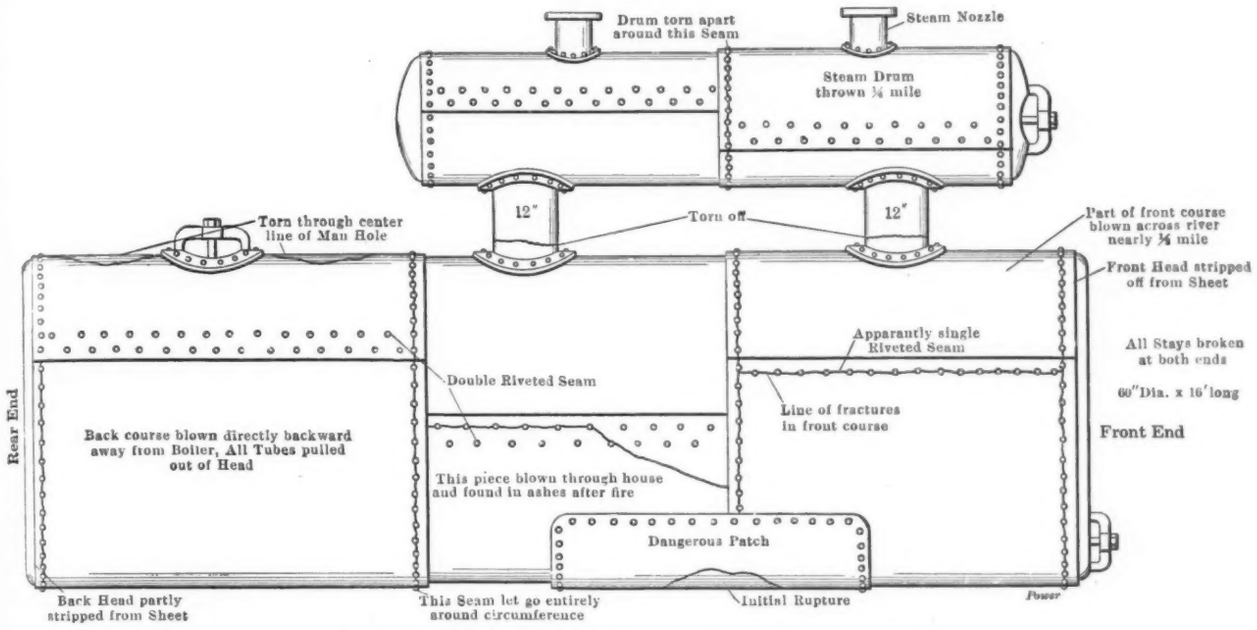

Drum torn apart around this Seam
Steam Nozzle
Steam Drum thrown ¼ mile
12"
Torn off
12"
Torn through center line of Man Hole
Part of front course blown across river nearly ½ mile
Front Head stripped off from Sheet
Apparantly single Riveted Seam
All Stays broken at both ends
60"Dia. x 16'long
Front End
Double Riveted Seam
Line of fractures in front course
Rear End
Back course blown directly backward away from Boiler, All Tubes pulled out of Head
This piece blown through house and found in ashes after fire
Dangerous Patch
Back Head partly stripped from Sheet
This Seam let go entirely around circumference
Initial Rupture
Power

FIG. 3. SKETCH OF BOILER SHOWING LINES OF FRACTURE

From a careful examination of the pieces it would seem that at one time the entire bottom of the front course had been taken out and replaced, the longitudinal joint in this case being single riveted, thus introducing another element of weakness.

FIG. 4. PART OF STEAM DRUM

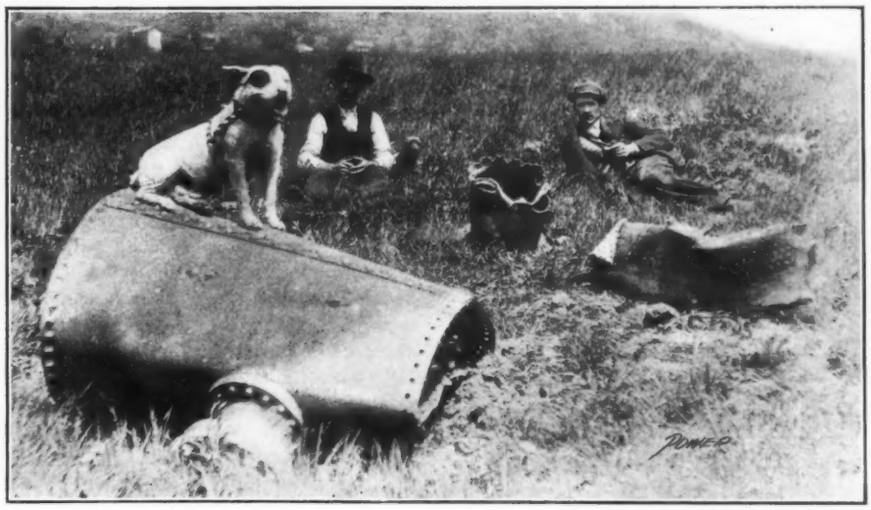


FIG. 5. OTHER PART OF DRUM

Gary, Ind., is to have a new power plant. Construction is already under way. Blast-furnace gas is to be used to develop electrical power for the plants of the American Sheet and Tin Plate Company, and the American Bridge Company. This new power plant is directly south of the present plant of the Indiana Steel Company and will be housed in a building 105x575 feet. There will be ten engines and generator units in the new plant, and each engine will be of a larger size than the engines in the existing plant. The cylinders in the new units will be 44x60 inches instead of 44x54 inches, and the generators will be 3000-kilowatt capacity, compared with 2500 kilowatts. The capacity of the new plant is estimated at 40,000 horsepower, or 30,000 kilowatts, which will be divided into ten units.

Inquiries of General Interest

Comparative Volume of Steam and Water

What is the volume of steam at 60 pounds pressure compared with the water from which it was made?

F. H. R.

One pound of saturated steam at 60 pounds gage pressure occupies a space of 5.7 cubic feet. One pound of water occupies 30.4 cubic inches or about 1/325 of the space of the steam.

Common Return for Two Circuits

Two generators supply current to two separate mining railway trolley wires and the track returns are connected by the same return feeder to the generators. Will voltage variations, grounds and short-circuits on one line affect the other one?

C. C. McI.

No; the two circuits will operate just as independently as though the return portions of them were not connected at all.

Generator Rating and Power Factor

What is meant by saying that a generator is a 300-kilowatt machine at 80 per cent. power factor? What has the power factor to do with the rating?

L. J. G.

It means that the machine will deliver 300 kilowatts if the power factor of the load is not below 80 per cent. The lower the power factor, the more current is required for a given amount of power; also, the greater will be the armature reaction on the field strength, and consequently the greater will be the exciting current required. Therefore, if a machine is built to give a certain power and voltage at a certain power factor, and the actual power factor is lower than this, then both the power and the voltage of the generator will be reduced.

Proper Amount of Lead

I have a book in which it is stated that when setting the valves of a steam engine, lead should be given, varying from 1/32 to ⅛ inch. How can I determine whether 1/32- or ⅛-inch lead should be given to have the engine run smoothly and cool?

C. W. V.

Lead is not given to a valve for the purpose of making the engine run either quietly or without heating. In fact, lead tends to produce both heat and noise. Lead is given for the purpose of providing for full steam-chest pressure on the piston at the beginning of the stroke.

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Only an indicator diagram will show when a valve has the proper amount of lead. If the diagram shows that full steam-chest pressure is realized on the piston by the time it has traveled 2 per cent. of the stroke, the lead is right.

Early Cutoff with the Slide Valve

I wish to make a small steam engine and have the cutoff take place early in the stroke. I have been told that lap is given to the slide valve to obtain an early cutoff, but that it cannot be made to take place before half stroke. I intend that the valve shall travel 2 inches. Can I make it cut off at quarter stroke?

V. A. M.

With a valve travel of 2 inches, cutoff will take place at quarter stroke if ⅞ inch lap be given to the valve. This will not make a very satisfactory arrangement, as the port opening will be only ⅛ inch and the steam will be wire-drawn. Slide valves are seldom designed to cut off earlier than five-eighths stroke.

Why Injectors Feed Boilers

How is it that an injector using steam at any pressure will force water into a boiler having the same or a higher pressure than the steam which operates the injector?

T. S.

Steam passing through the injector nozzle into the water in the combining tube is condensed and in condensing the particles of water preserve the high velocity with which the steam flows into the vacuum caused by condensation and impart to the water in the combining tube a velocity greater than the pressure in the boiler would give to a jet of water of the same size issuing from the boiler. The velocity of the jet overcomes the resistance due to the boiler pressure and the steam flows to the boiler.

Indicating "Idle" Current

Why is the idle current in an alternating-current circuit indicated by a wattmeter and not by an ammeter?

V. T. K.

It isn't. The wattmeter indicates the true power in the circuit and from this the energy component of the current can be computed; the geometrical difference between the total current and the energy component is the wattless component, commonly but wrongly called "idle" current. The ammeter indicates the full current in the circuit, which includes the wattless component; it cannot separate the current into its two components and measure one of them, for the same reason that a barometer cannot separate the tensions of the pure air and the moisture in the atmosphere and measure one of them, but measures the result of the combination. No one responsive device can discriminate between two similar forces which combine into a resultant than can affect the device. The wattmeter has two magnetic coils which react on each other, one responding to the current and the other to the voltage of the circuit, and because of the phase relation between the current and the voltage of the circuit the reaction responds to the average of the instantaneous resultants formed by the energy component of the current and the voltage.

Safety Valve and Pump Calculations

Please give me short directions for figuring safety valves and tell me the capacity of a 6 and 4 by 6-inch steam pump.

M. A. S.

For safety-valve calculation let

A = Area of valve in square inches,
D = Distance of ball from fulcrum,
d = Distance of valve stem from fulcrum,
P = Pressure at which valve will lift,
W = Weight of ball,
w = Effective weight of valve lever and stem.

Then for the pressure P at which the valve will lift,

$$P = \frac{WD + wd}{Ad}$$

To find the distance D of the ball from the fulcrum, transpose the formula to read,

$$D = \frac{(AP - w)d}{W}$$

and to find the weight, transpose to,

$$W = \frac{(AP - w)d}{D}$$

A pump having a water-piston diameter of 4 inches and a stroke of 6 inches will deliver 12.56 times 6, or 75.36 cubic inches of water per stroke. As there are 27.7 cubic inches in a pound of water, each stroke will deliver 2.7 pounds. At a piston speed of 100 feet per minute, the usual speed limit advised by the makers, it will deliver 200 times 2.7 or 540 pounds per minute.

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Power and The Engineer

Editorial

Boiler Explosions

Daily reports of boiler explosions with attendant loss of life and limb emphasize more than anything else could, the necessity for compulsory and frequent inspection of all steam boilers.

If a man or a corporation desired to manufacture gunpowder and built a factory for the purpose in a thickly populated community, either the factory or the community would move. But in most communities a man or a corporation may install and operate a steam boiler of any capacity or degree of decrepitude without let or hindrance.

Many fear the potential energy of gunpowder, but few know that there is nearly as much energy stored in a cubic foot of highly heated water as in a pound of gunpowder, and a boiler with its hundreds of cubic feet of water may be placed where a single keg of powder would not be tolerated.

The statute books of States and the ordinances of municipalities are spattered with rules which provide that men who operate engines and boilers shall be qualified engineers, while few States and cities make any provision for the inspection of the palpably dangerous apparatus which the engineer must operate.

Massachusetts and some few other States, the city of New York and other municipalities have taken a position in compulsory boiler inspection that approaches that of Great Britain, where in the year 1908 but seventy-three explosions occurred in the entire Kingdom, both on land and sea, and one of these was a coffee urn in a restaurant. When it is considered that many of these failures occurred in apparatus and appliances such as heating systems, steaming kettles, drying cylinders, steam chests and piping which cannot in any sense of the word be called steam boilers, the disparity becomes still more apparent. Deducting these from the total number of failures of all kinds, leaves thirty-five as the total number of failures in steam boilers proper out of more than 150,000 in actual daily use.

In Germany, the government reports for 1907, the latest available, give sixteen as the total number of explosions for the year.

For twenty-four years the average number of boiler explosions in Germany has been sixteen, and in Great Britain for the same period the average number has been sixty-nine. In the United States the number of boiler explosions reaches the almost incredible figure of three hundred and fifty per year.

These figures are a horrible indictment against the United States and call for legislative action of some kind that will put a stop to the wholesale slaughter of human beings.

Since the boiler-inspection laws of the State of Massachusetts have gone into effect, not one boiler under the jurisdiction of the district police has exploded. Boilers which have been condemned by the State inspectors as unsafe have been bought by irresponsible or ignorant power users and taken where no inspection laws hamper the individual in his search for cheap power-plant equipment.

There may be constitutional reasons why a Federal law compelling intelligent inspection of all boilers and steam receptacles in the United States may not be enacted, but there is no human reason why the several States of the Union should not make reasonable rules for the protection of people who work or walk in the vicinity of steam boilers.

Hiding the Facts

When an industrial accident which involves the loss of life as well as the destruction of property occurs, there is often an attempt on the part of the owners to conceal or misrepresent the true condition, especially where the technical press is concerned. That the facts, if published, would reflect upon the management or the apparatus must be the inference from such a course. It has been more or less falsely claimed by managements that the makers of the apparatus which failed were entitled to some protection from adverse criticism, while it is more than probable that the real purpose of concealment is to gain time in which to destroy, if possible, any evidence of criminal neglect on the part of those who may possibly be held responsible.

There is, however, one form of annoyance to which both the owner and the maker of the apparatus is subject, which gives a valid excuse for excluding the general public from the scene of a disaster. This is the tactics of the shyster lawyer who, like the vulture, thrives upon the misfortunes of others. He, it is, who often gets the ear of the bereaved or injured and by specious misrepresenta-

tions keeps the principals separated, preventing an adjustment and in the end pocketing the major part of what belongs to the client. But to escape this is no justification of the exclusion of intelligent expert investigators seeking the prime cause, which found, may prevent a similar disaster elsewhere.

To have defects and failures publicly analyzed by men who are really seeking the cause of failure may not be pleasant for the manufacturer who furnished the apparatus which failed.

It is certain that in every case of failure either the apparatus was defective or was improperly handled, perhaps both, and every individual has the right to the fullest information obtainable.

To attempt to conceal facts from legitimate investigators, to hinder or prevent investigation or to destroy evidence that might lead to the placing of the responsibility is culpable.

Immediately following the boiler explosion at Canton, an attempt was made on the part of the technical press to obtain permission to investigate and, if possible, locate the cause of the failure. This permission was denied by the management, and statements were made that the boilers had been recently inspected and found to be in good working order.

History Repeats Itself

"Men grow old and ripe in experience and die, and new generations, instead of profiting thereby, make decisions and conduct themselves according to their own limited knowledge of the world; therefore we do not progress in the ratio which is theoretically possible. Knowledge accumulated since the world began should make us the wisest of the race, and while this is true in a certain sense, still the most obvious mistakes are made over and over again, in matters which should be thoroughly settled by precedent."

The foregoing came to mind as the writer stood watching the installation of a battery of horizontal water-tube boilers in a new power house. Space was limited and the boilers were crowded to an extent that gave only the necessary working room around them. Knowing that sooner or later tubes must be renewed in any boiler, the observer noticed that when this operation became necessary in this particular case it would require the cutting away of an eighteen-inch brick wall. There never was a case where vertical boilers were more surely "indicated" than in this installation, as the building already occupied all the space available. Headroom was ample, and the boilers being installed were about the least suitable for the conditions that could be found. Another feature of the case was the fact that by virtue of a combination of good salesmanship and poor engineering these boilers were being installed practically in the front yard of a factory engaged in building just the boiler which should have gone in here. After being shipped hundreds of miles to the home of their rival, they were being placed in a plant where they could not acquit themselves with credit and where the peculiar characteristics of the home boiler would have offered the best solution of the problem.

The Carroll Patents

The prospectus of the Carbonic Engine and Power Company says that the inventions of John E. Carroll, by which "the tremendous expansive power of carbonic-acid gas may be safely and successfully used, are fully covered by patents issued and applied for, not only in America but in several foreign countries."

So far as a careful search of the United States patent records back to 1902 shows, only two patents have been granted to John E. Carroll. The first, No. 847,995, of March 19, 1907, is for a gas-demonstration apparatus, which is simply an insulated pipe. The sole claim reads, "I claim a gas conduit embodying a pipe, a fiber lining therefor, and a fiber covering or jacket around the pipe, substantially as described." The second is for a boat-propelling apparatus, and provides for a series of propeller shafts set at an angle with the expectation that the downward thrust of the propellers will lift the boat and make it run more easily. If there are any patents explaining how he intends to make a source of power out of an incombustible gas they must be among those pending.

Lack of Definite Data

Engineers have long been accused of neglecting the bookkeeping side of the business and devoting all of their attention to operating details, and surely the keeping of records has been the last item to receive its proper amount of attention. In fact even now it is only in the more important plants that adequate cost records are available. How often are we confronted with some such statement as this: "The new machinery is running nicely and shows a large saving over the old equipment but I have no definite figures as to the exact amount of saving."

The bookkeeper in the ordinary establishment can tell how many tons of coal are burned in a given period, what the wages were in the same period, and can name a lump sum which the power department has cost during that time. But the detailed information as to cost, the kind of information that the engineering world wants, is not so readily available. This lump-sum method is, in a way, satisfactory to the owner as he is concerned mainly in the total amount that the power costs him per week or per month. It should not, however, be satisfactory to the operating engineer. He should know more about the commercial details of the apparatus he operates.

Frequently a plant is laid out under conditions that are ideal for comparing the performance of different classes of equipment and obtaining valuable cost data, but the opportunity is neglected. One plant had two gas engines of the same size doing the same class of work, one running on natural gas and one on producer gas. Here interesting comparative cost data would have been easy to obtain, yet beyond the fact that one unit ran much more economically than the other, nothing was known.

Engineers are, or should be, anxious to make progress, and if they would only realize what a favorable impression is created by the ability to make definite statements as to power costs they would, perhaps, give more attention to this subject. It is assumed by the average visitor to a plant that if a man readily can answer questions regarding this important, though usually neglected, branch of his business he must be proficient in the mechanical details of his work.

Engineering matters, in common with all other human affairs, of necessity must be reduced to the common basis of dollars and cents and the engineer who has all the cost detail of his own plant at command stands a much better chance of stepping into a larger sphere.

A candidate for the position of engineer and superintendent of a large institution was under consideration. "I know him," said he whose word would settle it, "a good engineer—but *too coarse.*" The fact that he looked, talked and acted like a gentleman and was at home in the Board of Directors' room as well as in the engine room has got and kept many a man a gilt-edged job.

New Orleans is pressing its claims for the international exposition which will celebrate the completion of the Panama Canal in 1915. Lousianna will contribute four million dollars to the fund.

Be sure you are right, then go ahead" is a well known adage, but there are a lot of us who are sure we are right and never go ahead.

After a bearing has once been allowed to get hot it is likely to cause trouble from the same in the future. The remedy is simple—do not let it get hot the first time.

It is better to attempt to do things and succeed only once in a while than to sit back and say I can't.

Every time the fire under a boiler starts to settle down the fireman generally stirs it up.

New Power House Equipment

Herrick Balanced Rotary Engine

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

A new design of rotary engine has just been placed before the public by the Herrick Engine Company, of New York City. It is the outcome of some nine years of experimental work by the inventor, Gerardus P. Herrick, and possesses some interesting features which seem to warrant more than a passing notice.

The engine herein described and illustrated is of about 20 horsepower capacity and has been subjected to a number of efficiency tests besides having been in actual service for some months. A larger one of about 100 horsepower capacity has just been completed but as yet there has not been time to make any tests upon it.

Fig. 1 shows the engine complete while Fig. 2 shows it with the side casing removed. In fundamental principles it is not unlike many other rotary engines, in that the power is applied directly to the shaft by the expansion of steam behind a rotating piston. There are two rotors in rolling contact, the upper one containing a recess which serves as a steam inlet and allows the piston on the lower rotor to pass, while the lower one contains the piston and transmits the power to the shaft. The synchronous

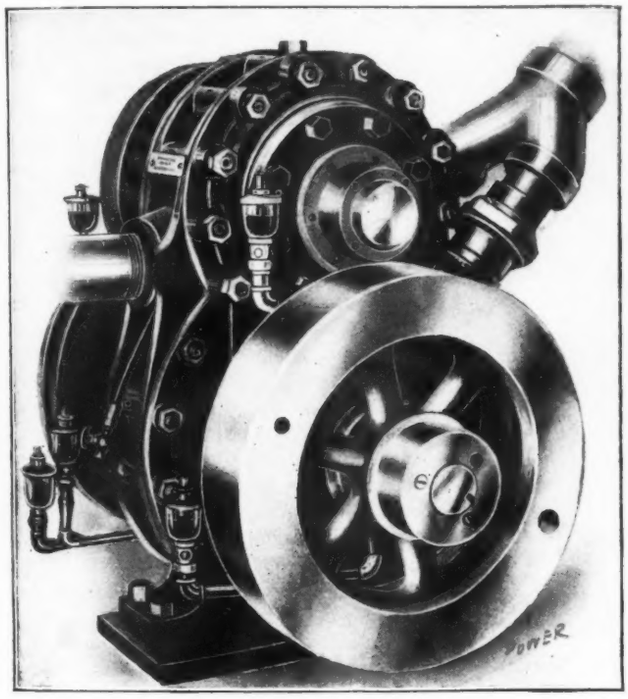


FIG. 1. ENGINE COMPLETE

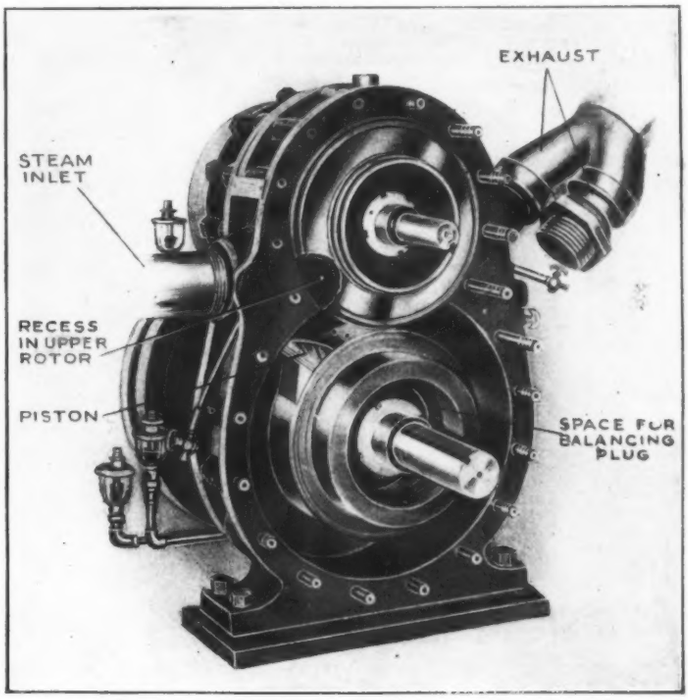


FIG. 2. ENGINE WITH BALANCING PISTON REMOVED

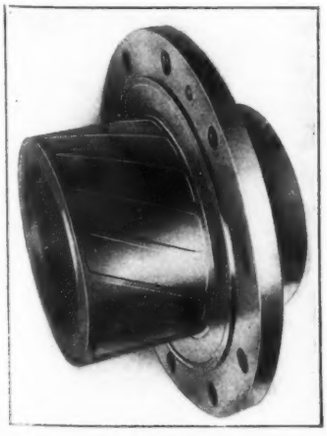


FIG. 3. BALANCING PISTON

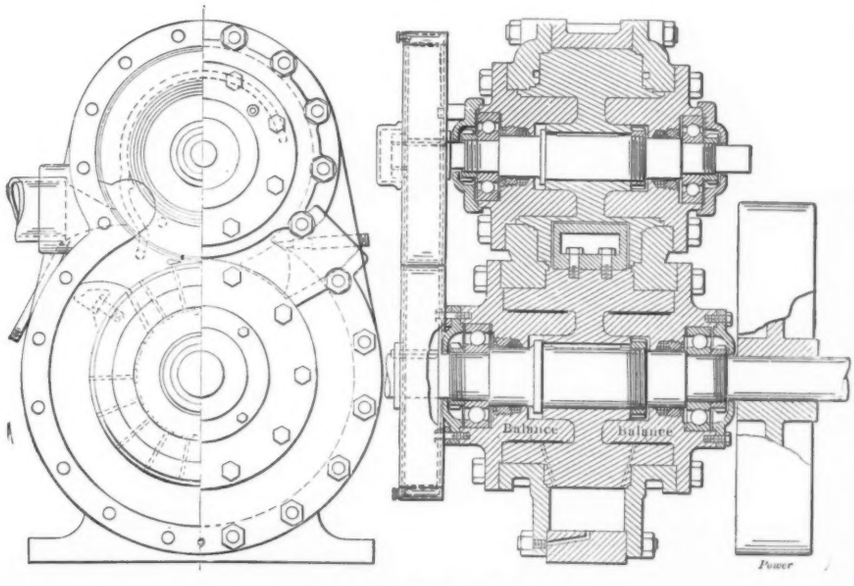


FIG. 4. DIAGRAM OF ENGINE

movement of the two rotors is maintained by means of two timing gears on the far side of the casing. The shaft is carried on ball bearings situated outside of the steam space, and thus renders the lubrication a very simple matter.

the steam is made to counterbalance its own pressure toward the bearing and to drive the piston without nullifying its working force.

A working drawing of the engine is shown in Fig. 4. For convenience of illustration the right-hand diagram shows the piston as being in the recess of the upper rotor, while the left-hand diagram shows it at cutoff. The load and balancing, for the same reason, are shown at the bottom.

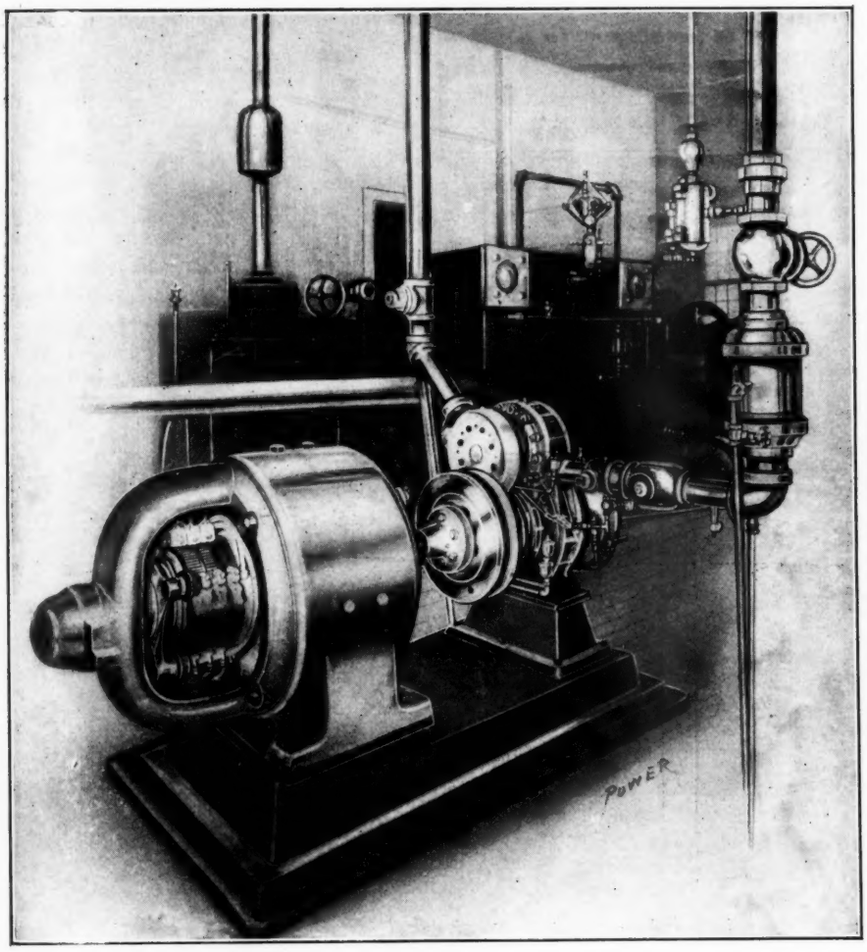


FIG. 5. ENGINE IN SERVICE AT PLANT OF THE DEGNON CONTRACTING COMPANY

One of the principal drawbacks to a successful rotary engine, heretofore, has been the fact that when steam at a high pressure was used to drive a piston in a circular path, it exerted such a pressure upon the central bearings that a large amount of power was lost in overcoming the friction. In the elimination of this difficulty lies the novel feature of the Herrick engine. This is accomplished by a balancing plug shown in Fig. 3. The steam is allowed to pass through the small radial holes in the rotor (see Fig. 2) and to act upon a series of stationary balancing chambers, 1/32 inch deep, situated around the circumference of the balancing plug, the latter fitting between the bearings and the cylinder and bolted to the casing. As the piston revolves and the area of the rotor exposed to steam pressure increases, the counterbalancing area, produced by the admission of steam to the successive chambers, is equally increased, thereby keeping the primary load and the balancing load equal. Thus

A commendable feature of the engine is its simplicity, there being only nine parts exclusive of bolts and nuts. It runs at approximately 1000 revolutions per minute, is 25 inches high and weighs slightly over 800 pounds.

A series of tests have been conducted upon it by Professor Pryor, of Stevens Institute, the results of some of which are here given. Preliminary tests were made in July, 1909, after which the engine was given an endurance run by being set up in the plant of the Degnon Contracting Company and operated for 1685 hours, representing 66 days of 17 hours each. During this time it operated satisfactorily. Fig 5 shows the engine under these operating conditions and from it may be gained an idea of the relative size of the engine.

Table 1 gives the results of the preliminary tests previous to the endurance run, while Table 2 gives the results of tests subsequent to the endurance run. In comparing the two sets of figures it will be noted that for a given pressure and equal number of revolutions, the engine used less steam on the second trial than it did on the first. This would indicate that there was less leakage after the endurance run than before. But it will also be noticed that there was a decrease in brake horsepower developed. The decreased leakage did not, however, exactly offset the decrease in horsepower; hence there was a slight increase in the steam consumption per brake horsepower-hour. Professor Pryor explains this by the fact that upon taking the engine apart after the test, it was found that some of the revolving parts which should not have been in contact, showed signs of rubbing, the probable cause of this being that the bearings had been changed during the endurance run, thereby affecting the alinement. In a subsequent test at 135 pounds pressure with steam superheated to 50 degrees Fahrenheit, the steam consumption was reduced to 44.4 pounds per brake horsepower-hour. In none of these tests was the engine lagged or protected from radiation losses in any way, and it is reasonable to suppose that had such protection been employed, a better performance would have resulted.

TABLE 1. TESTS PRELIMINARY TO ENDURANCE RUN.

Duration of Tests, Mins.	Steam Pressure After Throttle, Lb. per Sq.In.	Revolutions per Min.	Water per Hour, Lb.	Generator Readings. Volts.	Amperes.	K.W.	Brake Horsepower.	Water per Hour per Brake Horsepower, Lb.
STEAM—DRY SATURATED. EXHAUST—ATMOSPHERIC.								
40	105.3	1010	782.6	228.06	38.61	8.80	13.38	58.5
40	115.3	1012	855.4	227.80	45.38	10.33	15.58	54.9
40	125.6	1007	920.6	228.17	50.19	11.45	17.18	53.6
40	135.2	1010	979.9	227.80	55.27	12.59	18.82	52.0
40	145.0	1006	1039.1	228.67	60.12	13.74	20.48	50.7
STEAM—DRY SATURATED. EXHAUST—18.4 INS. OF MERCURY.								
40	105.6	1000	790.9	227.57	51.74	11.77	17.64	44.9
40	115.2	1012	862.5	227.96	57.36	13.07	19.52	44.2

TABLE 2. TESTS SUBSEQUENT TO ENDURANCE RUN.

Duration of Tests, Mins.	Steam Pressure After Throttle, Lb. per Sq.In.	Revolutions per Min.	Water per Hour, Lb.	Generator Readings. Volts.	Amperes.	K.W.	Brake Horsepower.	Water per Hour per Brake Horsepower, Lb.
STEAM—DRY SATURATED. EXHAUST—ATMOSPHERIC.								
40	105	1007	728.3	226.22	31.41	7.11	11.30	64.5
40	115	1017	764.5	228.72	37.04	8.47	13.23	59.3
40	125	1013	854.3	229.19	42.58	9.76	15.10	56.6
30	135	1010	934.0	228.50	48.21	11.02	16.95	55.1
40	145	1010	1007.3	228.17	54.70	12.48	19.15	52.6
STEAM—DRY SATURATED. EXHAUST—19.2 INS. OF MERCURY.								
30	115	1008	830.0	229.57	53.81	12.36	18.95	43.8
STEAM—DRY SATURATED. EXHAUST—ATMOSPHERIC. NO LOAD.								
30	43	1015	359	.....	.....	.....	1.5	239.3

Fig. 6 gives curves of total water consumption and water rate per brake horsepower-hour, plotted from Table 2, with dry saturated steam and exhausting into the atmosphere.

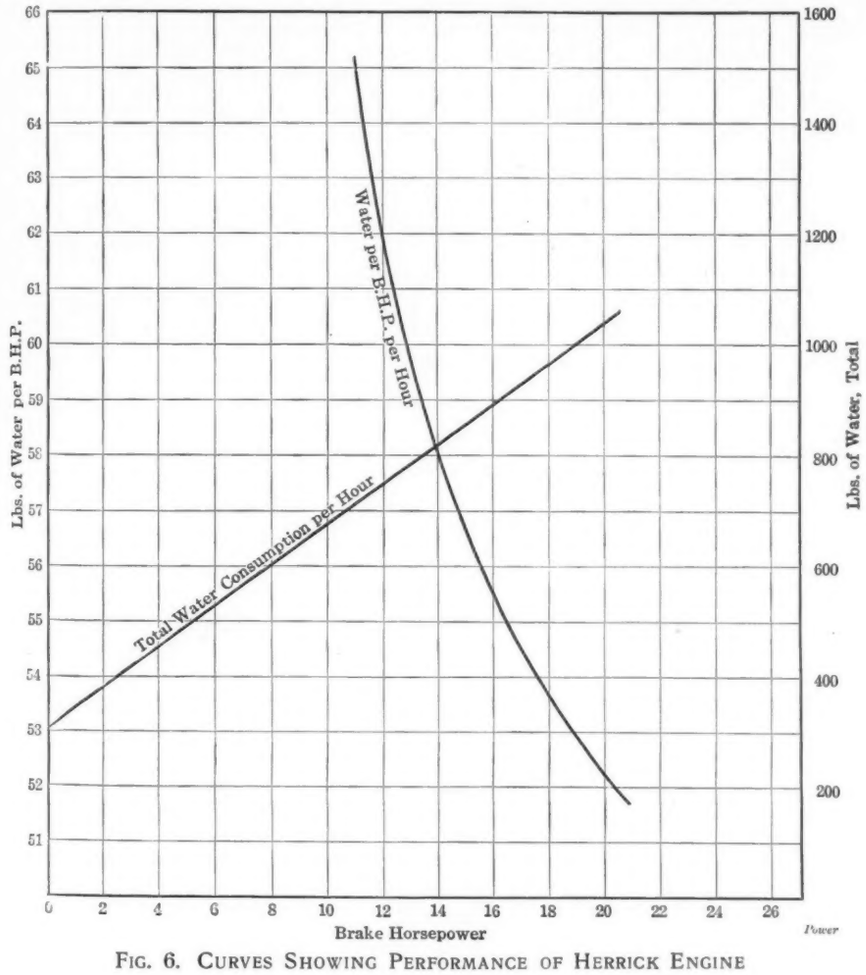


FIG. 6. CURVES SHOWING PERFORMANCE OF HERRICK ENGINE

The builders frankly admit that there is leakage in the engine, but point to the fact that in combination with a turbine this leakage would be utilized. Several authorities have claimed phenomenal results from such a combination, but as these are mere conjectures, we must wait for actual results before expressing an opinion.

One thing is certain, the engine shows a favorable water rate for its size and is simple in construction; and keeping in mind the fact that it will be subject to certain modifications and improvements as suggested by practical operation, Mr. Herrick is to be congratulated upon having made a start in the right direction. The engineering profession will await with interest the performance of the 100-horsepower engine which is about to be tested, as this size of engine will show more conclusive results than could have been expected from the smaller unit.

Peterson Individual Oiling System

This oiling arrangement has been perfected to meet the demand for a complete oiling and filtering system of such design as to admit of its being used with any type of steam engine. Fig. 1 shows the complete system applied to a Corliss engine. The oil filter and supply tank are shown on the filter stand which is attached to the engine frame. The receiving and separating tank is placed under the floor.

The system consists of a small receiving tank, Fig. 2, located at a convenient point, where all the oil drips will flow to it by gravity. This receiving tank automatically separates heavy particles of foreign matter and entrained water, after which the oil is taken up by the pump and delivered to the filter for final purification, and then flows by gravity to the various oil feeds.

The dirty oil enters the receiver through the connection *A* and passes into the automatic separating chamber *B* where the oil rises and overflows to the suction chamber. Entrained water and heavy particles of foreign matter are retained in the separating chamber. The water filling the overflow pipe *C* passes out through connections *D* and *E* which can be piped to the sewer or drain system as desired; *F* acts as a vent to prevent siphoning.

The pipe *G* is connected to the suction of the pump. A strainer is attached to the bottom of the suction pipe and can be slipped off for cleaning, by raising the tube. A removable dust-proof cover is held in place in slots.

The filter, shown in Fig. 3, is cylindrical in form, divided into two compartments, with removable cover, the bottom being provided with a 2-inch standard pipe flange, from which it is supported on the engine frame at an elevation of about 6 inches above the highest point to be lubricated.

The dirty oil in the separating chamber is taken up by a pump and delivered to the bottom of the filter, and, passing up through the tube *A*, is distributed over a conical strainer *D* through a perforated nozzle *C*. Both strainer and nozzle are removable for cleaning.

Passing through the strainer *C* the oil flows down through the tube *E*, discharging at the bottom through a perforated footing, which tends to break the oil into small streams. The dirty oil passing up through the water into this compartment (inside of cylinder *F*) is evenly distributed by the circular plate *G* attached to the tube *E*.

The separating chamber *F* should always contain about 10 inches of water. The hight of this water will be increased by entrained water coming over with the oil, but as the greater portion of water is removed in the automatic receiver and

separator, the accumulation of entrained water in the filter is very small and can be maintained at about 10 inches from the bottom, by drawing off the accumulated water through a cock *H* at the lower end of the gage-glass fitting.

be removed for cleaning by turning up to a vertical position and then pulling out the retaining rings in the filter chambers. Should it be desired to clean the filter bags and not interfere with the continuous operation of the system, one bag at a time may be removed and the other one continued in operation.

The purified oil leaves the filter through a bottom connection (it may also be drawn off for hand oiling at a cock at the lower end of gage glass), and flows by gravity through a pipe line to the various feeders and is then conveyed

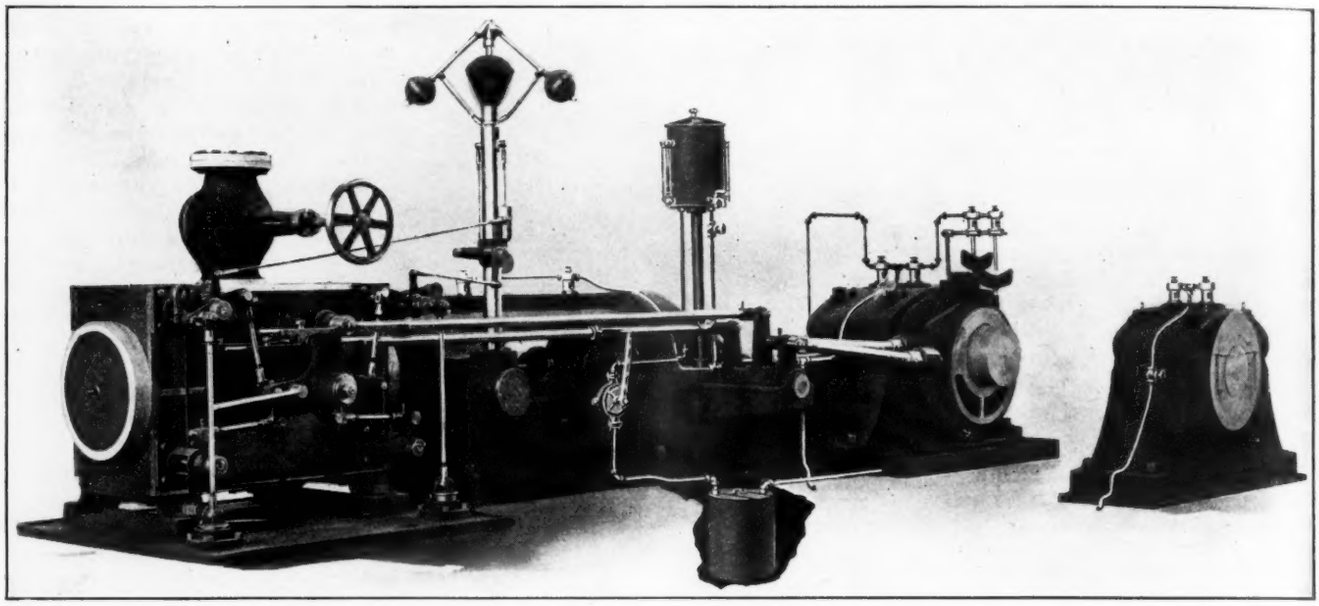


FIG. 1. ARRANGEMENT OF COMPLETE FILTERING AND OILING SYSTEM

The oil, after being separated from entrained water and heavy particles of foreign matter (which are precipitated to the bottom of separating chamber *F*) to the adjustable sight feeds at the various points to be lubricated.

A valve is inserted in the feed line just below the filter to regulate the sup-

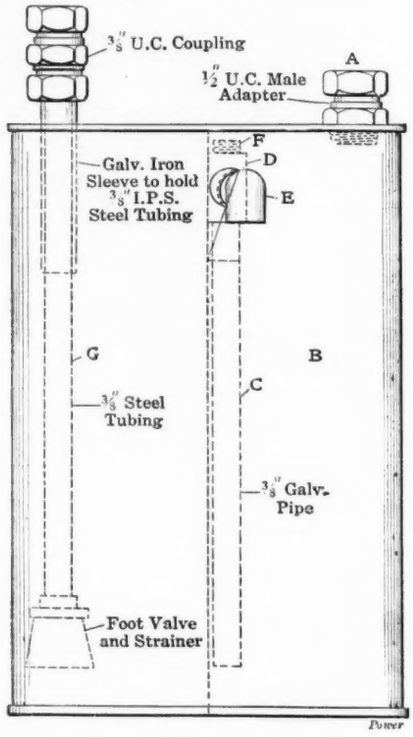
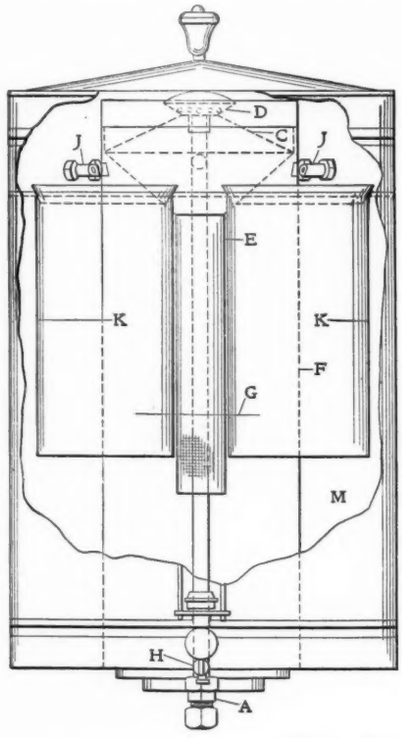


FIG. 2. RECEIVING TANK



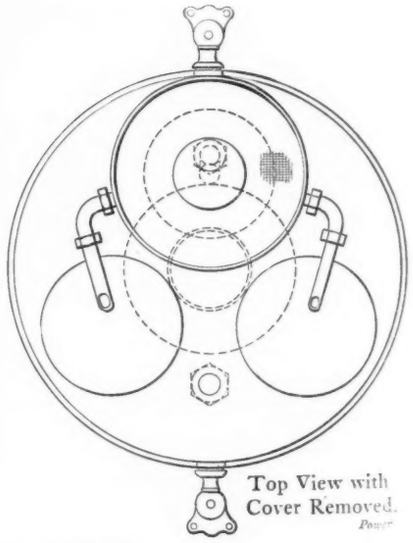


FIG. 3. DETAILS OF FILTER

rises to the top and overflows through two swivel connections *J J*, into the filtering bags *K K*, one or both of which may

the clean oil accumulates in the storage chamber *M*, which surrounds the separating compartment *F*.

ply of oil to all feeds. Fig. 1 shows the general arrangement of the entire oiling system.

The interior of the filter is readily accessible by removing the cover. The flange on the bottom of the filter is threaded for a 2-inch standard pipe, from which point it can be supported on the engine frame by a standard and base flange.

A special oil pump is provided, either of rotary, plunger or semi-rotary type, which may be belted or connected to the engine, as is most convenient.

At each point to be lubricated is placed a sight oil feed, with from one to four connections so that several may be piped up in a row, the oil passing on through one to the next, etc., or the body may be used as an elbow, the oil flowing in one side and out to the right or left to another feed, as convenient.

"Union-Cinch" elbows, tees, controlling valve, etc., with drawn-steel pipe are furnished for connections between the filter, receiving tank, pump and oil feeds so that the entire system can be connected up without threading, soldering, or flaring out the pipe ends. The joint between the pipe and fitting is made by inserting the pipe into the fitting and drawing down the nut, which compresses a metal ring around the pipe, making a pressure-tight joint.

The drawn-steel tubing is annealed so that it can be easily bent to conform to the shape of the engine or machine frame.

The individual oiling system is designed and manufactured by the Peterson Engineering Company, 50 Church street, New York City.

NEW PUBLICATIONS

NATURAL SOURCES OF POWER. By Robert S. Ball. D. Van Nostrand Company, New York. 348 pages, 5¼x8; cloth. Price, $2 net.

In this work the natural sources of power discussed are those forces which may be directly applied to prime movers, namely, wind and water. Much more than half of the work, which is written as much for the general as for the technical reader, is given to the treatment of water power, methods of measurement, its application to the propulsion of machinery, types of water-driven motors and the construction, installation and equipment of hydraulic plants. In the portion devoted to wind motors there are four chapters on wind pressure, velocity and methods of measurement, application of wind power to industry, constructional details of modern windmills and discussions of the power developed. There are over one hundred illustrations and several useful tables. Mathematical formulas of forbidding mien are conspicuous by their absence from the body of the work, a few appearing in the four-page appendix. The complete index, covering every item in the text, affords a ready means of reference which is sure to be appreciated by the seeker for information.

BOOKS RECEIVED

"Dynamo Building for Amateurs." By Arthur J. Weed. The Norman W. Henley Publishing Company, New York. Cloth; 110 pages, 4¾x7½ inches. Price, $1.

"Twentieth Century Handbook for Steam Engineers and Electricians." By Calvin W. Swingle. F. J. Drake & Co., Chicago, Ill. Leather; 1481 pages, 4½x6½ inches; 696 illustrations; indexed. Price, $3.

"Selt-Taught Mechanical Drawing and Elementary Machine Design." By F. L. Sylvester and Erik Oberg. The Norman W. Henley Publishing Company, New York. Cloth; 330 pages, 4½x7¼ inches; 218 illustrations; tables; indexed. Price, $2.

SOCIETY NOTES

The first annual meeting of the American Association of Refrigeration was held at the Hotel Astor, New York City, on May 9 and 10. Being a business meeting, purely business matters were discussed. Frank D. La Lanne, of Philadelphia, president of the National Board of Trade, who is also the honorary president of the Refrigerating Association, delivered an interesting address, highly commending the objects of the association, and felicitating the meeting upon its work and the high charater of its active offiials.

A complete list of officers was elected for the ensuing year as well as the chairmen of fifteen standing committees for undertaking the different scientific and commercial phases of the work of the association. A resolution related to threatened cold-storage legislation by Congress was unanimously adopted, as was also a resolution directing the executive committee to attend to presenting a bill to Congress authorizing the President to extend an official invitation to the Second International Congress of Refrigerating to be held at Vienna, Austria, next October, to hold the third congress in this country.

The officers elected are as follows: President, Theo. O. Vilter; vice-presidents, W. D. Hoard, E. D. McCormick, Charles Rohe, Col. Jacob Ruppert, Jr., W. J. Rushton, Thomas Shipley and John E. Starr; secretary, J. F. Nickerson; treasurer, John S. Field.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 3.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait, Association York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June 6-10, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

There's just as much art in being a good buyer as there is in being a good seller.

If you care to consult Mr. Dun and Mr. Bradstreet you'll find out that there is about one concern in fifty which succeeds in business. And if you could study the *successes* from an inside point of view, you'd learn that *good buying* had a lot to do with it.

You can't become a good buyer unless you keep constantly in touch with the best things being sold in your line. And you can't do this unless you read the ads.

The day is past when ads. are merely *tolerated*, like the train-boy who tries to sell you everything from hemp cigars to souvenir post cards. Most of the ads. in this paper are *good sellers*—and weekly association with them is bound to make *good buyers*. Someone once truly said, "Proportionately as a man's backbone weakens his 'wishbone' develops." Good buyers have good backbones—and reading the ads. in POWER each week is the best spinal developer.

* * *

Advertising began when the serpent entered into Eden with a very persuasive advertisement of the famous apple.

"Here," he said to Eve, "is something new, tasty and strictly up-to-date. You can't do without it."

And naturally, Eve, being a woman, bit at once.

Advertising has changed as much as men and women have since the Garden of Eden hung up the "closed for the Summer" sign.

As has been said before, the only devil connected with advertising these days is the printer's devil.

The manufacturer who wins out is the one who makes a reliable product, believes in it and advertises it.

The engineer who wins out is the one who squeezes every idea and value out of these reliable products, and applies them to his own—and his employer's—advantage.

* * *

Reports coming from certain sections of the West Indian Islands, during the past few weeks, of quantities of little pills sold to the superstitious blacks as certain protection against all the fearful evils of Mister Halley's comet, came as gentle reminders that *all* the quacks in the world are not yet dead.

But—to be perfectly frank—though the quack is fast disappearing, it's not *his* fault. The trouble is that the Day and Generation have become too wise for him.

Fake stuff won't go any more. It's only the Real Thing, the Genuine Goods, that can stay on its feet to-day, and grow.

Advertising has been accused of perhaps more than its fair share of Quackery. If, however, there ever was a time when the Ad. quack existed in sufficient numbers to be a real menace, that time has slipped back so far into the dim and dusky distance that it will take more than a Comet with a 30-million mile tail, to resurrect it.

Your advertising doctor realizes just as keenly as anybody else—perhaps more keenly than some others—that he is living in the Twentieth Century, not the Twelfth. He knows that the *only* possible way of keeping his head above water and becoming comfortably rotund and happy, is to preach nothing but the Straight Goods about Honest Products. And—

It's the man who reads the Advertising Pages, and buys Advertised Goods, who reaps the Golden Harvest.

* * *

Some weeks before the flood Noah got some inside information that the great deluge was on the way.

Being a kindly sort of chap he decided to advertise the fact and give everyone a chance to go into the ark building business for the purpose of self-preservation.

So he sent out pages among the people to advertise the coming of the famous down-pour.

But the people only laughed—they even scoffed.

They paid no attention to the advertising "pages."

And when the rain really began on schedule time they were amazed.

When the water rose to their knees, they were afraid—

And when it reached their top hair they were drowned.

And the moral:

Even in ancient history it was fatal to scoff at the advertising "pages."